ECONOMIC GEOGRAPHY

VOL. 9 APRIL, 1933 NO. 2

AGRICULTURAL REGIONS OF ASIA

PART IV—INDIA

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INDIA is a land of farmers. At least two-thirds of its 340 million people are directly supported by agriculture and many millions more are rather intimately associated with that industry, and dependent upon it for their livelihood. The Indian peasant forms the backbone of the country's economy, as is true in most of Asia; and the innumerable Indian villages, unchanged throughout the centuries, represent the actual life of India much more accurately than the larger modern cities.

The Indian peasant is poor, desperately poor! His small holding (in the United Provinces a minimum of 251 acres of cultivated land to every 100 farmers; in Bombay a maximum of 1,215 acres to 100 farmers), of which he is the owner (ryot), or only the tenant (zamindari), provides him with a small surplus only in favorable years, barely meets his simple needs in normal years, and brings him to the verge of starvation in disastrous years. His yields are small as compared with more temperate regions of advanced culture and even where the climate permits double cropping is a rare practice. His livestock, so essential to his industry and welfare, is generally underfed; it cannot be killed and eaten when it ages and becomes unprofitable for draft purposes, because religious prejudices make the slaughter of cattle a sacrilege, and the eating of meat a sin. If the peasant is able to produce a surplus in favorable years, he must generally turn it over to his moneylender, to whom he is in debt for interest or principle on the necessary loans in years of deficiency; only rarely is he able to reduce the principle. Even the very low land tax constitutes a heavy financial burden to most of the farmers.

But to make the peasant condition worse, the rapid increase of population (about one per cent the year) since the English assumed direct control of the country and reduced the hazard of war, famine, and disease which had previously checked the population growth, has further diminished the per capita acreage and further reduced the efficiency of the farm management and cultivation.

The Indian village is no longer self-supporting except where its detachment from the rest of the world by inaccessibility or isolation compels it to support itself. The village connected with the rest of the world by roads, railways, and steamship lines and thus imbued with the idea of cash crops and imported merchandise, could not readily adjust itself to the new conditions imposed by its new relationships. As a consequence the ancient home industries were ruined, and imported manufactured products

displaced home crafts, and made the slack season in agriculture a period of industrial inactivity.

	1771	1791	1811	1829	1840	1914
No. of Farmers...	24	41	54	58	60	156
Per Capita Acreage	44	25	19	18	17½	7

(From Mann, Harold: The Economics of an Indian Village.)

Already sorely overpopulated in relation to its present agricultural methods and resources, India continues increasing her population. Her climatic conditions inexorably limit her agricultural potentialities; only a drastic reduction in the rate of increase of her population can solve India's serious problem for the future, or substantially improve the material standard of living for her people.

The most inspiring hope for the future lies in the extension of irrigation. Following the period of selfish and ruthless exploitation, the period of coöperation and assistance inaugurated by the British Government has appreciably improved the situation in India; whatever the merit of the means employed, the sincerity of the British plan for improving conditions in India is indisputable.[1] The acreage of cultivated land resulting from the extension of irrigation, particularly of the perennial type has steadily increased. Crop production has been made possible in regions which were formerly incapable of cultivation successfully or economically, and in other regions the yields were considerably increased, and weather hazards eliminated. Drainage canals protect the crops of the lower valleys against the menace of flood and freshet. Agricultural Experiment Stations have developed new varieties of crops and extended their limits, and by exhibitions, fairs, and other demonstrations have introduced and popularized better methods of plowing, fertilizing, harvesting, and storing. They have organized coöperative societies which now include a membership of over four million, to provide local credit as a substitute for the usurious loans from the money-lenders, to provide and distribute selected seed among the farmers, and to improve the quality of the livestock.

The report of the Royal Commission on Agriculture, published in 1928, exemplifies the effort to improve conditions and recommends plans for further improvement.

In the following treatment of Indian agriculture, the plan is first to treat the basic factors, relief and climate; and then to present in more detail the distribution of the more important crops. Upon this basic treatment will be built up the different agricultural regions.

LITERATURE

The literature on Indian agriculture is so abundant and extensive that to try to cite all of it would be futile; but an excellent summary of the general literature in the field constitutes the appendix to the valuable study "India as a Producer and Exporter of Wheat," in Volume 3 of the "Wheat Studies of the Food Research Institute," Stanford University, 1926–1927, a much more exhaustive study of agricultural conditions in India than its title indicates.

Th. H. Engelbrecht's "*Die Feldfruchte Indiens in ihrer geographischen Verbreitung*" in Band XIX. *Abhandlungen des Hamburgischen Kolonial Instituts*, 1914 (text and atlas) remains the classic and exhaustive authority, used for reference through-

[1] A critical review of Great Britain's attitude toward India's problems is presented by Zakir Husain in "Die Agrarverfassung Britisch Indiens —Berichte über Landwirtschaft"; Neue Folge, Sonderheft 25, Paul Parey, Berlin.

out the preparation of this study. "The Development of Indian Agriculture" by A. and G. L. C. Howard, Oxford University Press, is rich in valuable information and supplies also an up-to-date bibliography.

Another general bibliography on the subject is published in the *Journal of Geography*, February, 1931. The Department of Commercial Intelligence and Statistics of Calcutta publishes annually statistical reviews which supplement the complete decennial census. The Central Publication branch of the Calcutta Government of India also publishes a helpful annual report.

THE LAND

An uninterrupted mountain mass separates India from the rest of Asia, and segregates it as a distinct geographical unit unique in its vast area and the completeness of its isolation. Few passes break its continuity, and these are either very high and blocked by snow most of the year or open upon desert interior basins. The Khyber Pass, leading by the famous Kabul Valley into Turkestan, has ever formed the best pass through this great mountain wall, but it has remained hazardous for trade and travel even under strict British control reinforced by the most modern means of warfare, for the fierce mountain tribes surrounding it have remained implacable brigands, and enemies of Britain. Again and again the Khyber Pass has formed the gateway into India for racial and cultural invasions that have modified and developed India's people. Through the Khyber Pass swept the early Aryans to dominate the plains of India with their racial and cultural strength and to push the former Dravidian peoples, also foreign invaders, southward toward the peripheries and inaccessible sanctuaries of the peninsula. Through the Khyber Pass marched gloriously the army of Alexander the Great to bring to India the brilliant civilization of the Hellenic world without modifying the people politically.

Mongoloid tribes descended the Himalayan valleys to occupy portions of the Ganges-Brahmaputra lowlands. Mohammedan zealots spread out from the Iran Plateau over the dry pastoral grasslands and thorn forests of the Indus plains to rise to power and supremacy in the Mogul empire, which embraced most of India when the first Europeans began to penetrate this portion of the Orient, and thus to usher in the last phase of invasion in the political and cultural institutions of western Europe, chiefly British. The final invasion was accordingly not by mountain pass but by sea, and ocean transport and travel have concentrated international contacts in modern times on the coastal periphery, to leave the mountains the barrier wall they have ever remained.

South from the mountain wall and its piedmont lie the Indo-Ganges Lowlands, including the lower Brahmaputra valley. Two thousand miles from east to west and 150 to 200 miles from north to south, these lowlands are throughout so nearly level that the almost imperceptible divide between the Ganges and the Indus rises only 500 feet above sea level, well nigh the only relief within the region. The difference in soil is more conspicuous than the difference in elevation. The lowlands form a vast geocyncline between the Alpine Himalayas and the Deccan Plateau, in which the rivers seem an inconsiderable feature on the flat vastness.

The Deccan Plateau, with its uplifted edges, forms the rest of India, of which the western rim comprising the Western Ghats rises highest. The plateau is bordered by narrow coastal plains, narrowest on the west and widest in the east. The greatest width of the eastern coastal plain is in the south where the eastern lowlands adjoin the Western Ghats south of the Palghat Gap, the only break in the western wall.

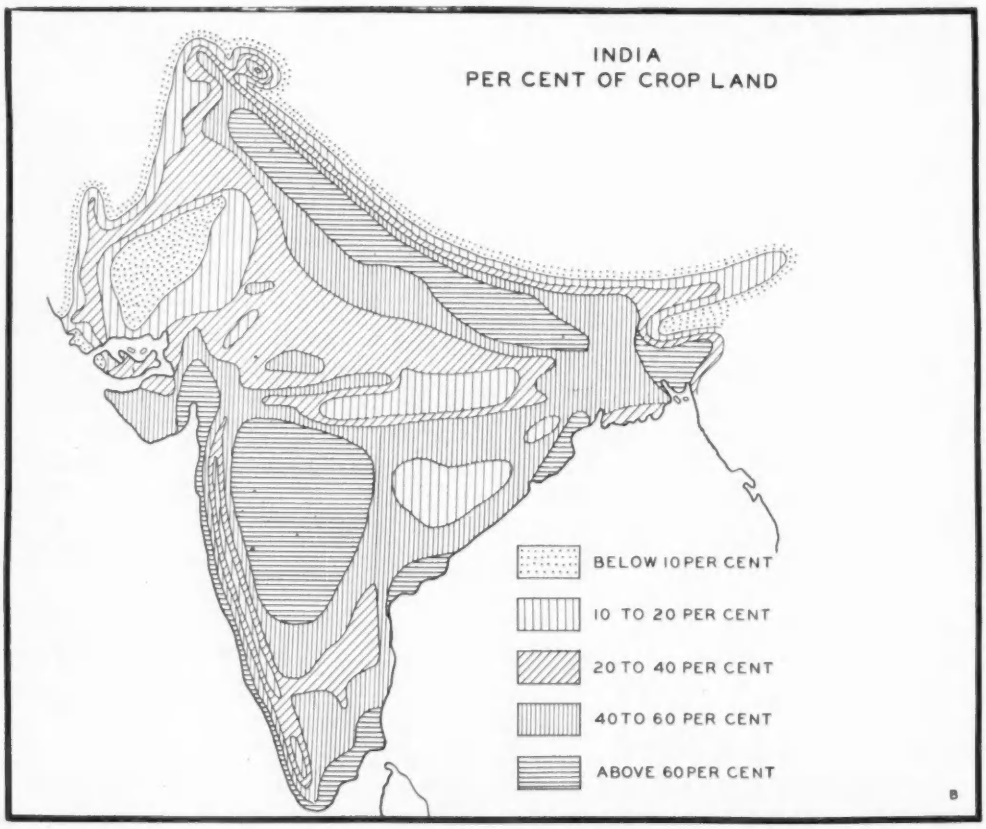

FIGURE 1.—The percentage of the area of India in crop land reflects the complex of physical factors—relief, climate, and soil, particularly—so dominantly that other elements in the environment can almost be considered negligible. The agriculture of India is so dominantly a crop agriculture and the livestock industry and silviculture so relatively unimportant, that the distribution of crop land likewise reflects the agricultural occupancy of the country. (Simplified from map by Wellington D. Jones in the *Geographical Review*, July, 1929, issue.)

Relief plays but a small part in the character of the land utilization of the Deccan Plateau, except along the steep slopes of the Western Ghats. The plateau forms a rather flat to rolling tableland in which the eastward-flowing rivers have eroded themselves deep. North of the double rift of the Narbada and the Tapti, the limit of the true Deccan Plateau, the transition from the Deccan tableland and the Indo-Ganges plain comprises a wider variety of relief which approaches a rough mountainous cordillera in the higher eastern portion, the Chota Nagpur Mountains.

The soils of the Deccan lack the uniformity of the alluvial deposits of the Indo-Ganges plain, for while such alluvial soils are distributed in places

along the coasts and in the river valleys, the upland soils reflect strongly the local differences in climate and the geologic parent material from which they are formed. The regur, or black, soils of the cotton area characterize the whole section of trap outcrops on the Bombay Deccan formed by tremendous outflows of lava; but even the regur are in part result of the climate, for they do not coincide with the distribution of the trap. The high value of the regur soils, and their productivity, is consequent not only upon their inherent fertility, but on their capacity of retaining the precipitation from the rainy season, as a store to support winter crops.

Red soils formed under similar climatic conditions as the regur overlie the metamorphic rocks of southern and eastern Deccan, but because they are not so retentive of moisture, they require continual rainfall or irrigation to be productive. In regions of heavy rain and shorter dry seasons, lateritic soils of low fertility as a consequence of prolonged and effective leaching, require irrigation and manuring to grow crops.

Figure 1, showing percentage of land area under cultivation, reveals the Western Ghats and the northeastern mountains as areas of limited cultivation, and indicates a relatively low percentage of cultivated land on the more complex transition zone between the Deccan and the northern plains. The precipitous rise of the northern mountain mass abruptly terminates Indian agriculture northward except in the Kashmir Valley, an agricultural oasis encircled by unproductive mountains. The area of greatest use of the land on the Deccan Plateau coincides closely with the regur soils rather sharply set off from the less favorable red soils southward and eastward. A thorough description of the Deccan soils is given in Supplement 2 of the *Geographical Teacher* in an article, "The Agricultural Geography of the Deccan Plateau of India," by Ethel Simkins.

CLIMATE

During the winter period pressure is highest over the cool land and diminishes toward the encompassing warmer sea, but it decreases most notably from northern India with its more continental location towards the low pressure area south of the Equator, resulting in a strong northerly wind out of India. Because the Himalaya Mountains constitute an exceedingly effective barrier to the movement of the lower atmosphere, the winter monsoon of India originates locally and is not affected by the extreme cold of interior Asia north of the mountains. As it issues from the land, the relief makes it northwesterly on the Ganges plain, but as it leaves the land, the rotation of the earth deflects it toward the right so that in lower latitudes it becomes a northeast wind indistinguishable from the regular trade winds of those latitudes. Since it is a land wind blowing from colder to warmer regions, it is a dry wind, and not productive of precipitation even when forced to rise over a mountain barrier except after it has traversed a long distance of warm sea—as in the case of the Bay of Bengal yielding moisture to the wind to fall in heavy rain on the east coast of Ceylon. The uniform aridity of India in winter is interrupted only by shallow cyclonic storms of Mediterranean origin moving southeastward along the Himalayan front, and yielding moderate winter rain which plays an

exceptionally important part in the agriculture of northern India. Though the cyclonic storms decrease in intensity eastward, they usually bring appreciable precipitation to the Deccan foreland and the lower Ganges; but their principal rôle in Indian agriculture is in the northwestern provinces and the Himalayan piedmont of the Punjab.

January temperatures increase normally from 50 degrees at Peshawar to 80 degrees in Ceylon. Occasional cold waves with temperatures below freezing during clear nights may sweep over the northern provinces, but the average temperatures are anomalously high for the latitude as a consequence of the equatorial heat introduced by the returning southwestern anti-monsoon which banks against the barrier Himalayas and spreads over the plains below.

In spring pressure conditions are unstable, the outblowing winds cease, and increasing insulation warms the land rapidly and begins the hot season of India relieved only by onshore winds and spring storms, storms that yield rain in southern India and some sections of the Bengal coast, as in Assam. In general India is hot and dry, with temperatures frequently higher than 100° F., from which there is no escape except by climbing to higher altitudes. The maximum inflow of equatorial air from the tropical high pressure area south of the Equator to the rapidly developing continental low is prevented throughout early spring by the relatively high pressure region over the Arabian Sea just north of the Equator.

In June the monsoon breaks abruptly, and the third season—the rainy season—begins. Humid winds blowing upon the land from a general southwesterly direction locally diverted by topography distribute rainfall over India, the precipitation decreasing northward and landward both in amount and in duration, except where relief locally affects conditions. As the rainfall map indicates, heavy precipitation characterizes the west slope of the Western Ghats, while the Deccan Plateau lies in their pronounced rain shadow. Over the northern part of the Bay of Bengal the southwest winds shift to the southeast, drawn by the low pressure over the warm Indo-Ganges plain. The combined effect of the southwesterly and southeasterly winds is to cause more rain over the Chota Nagpur Mountains, and heavy rain along the Himalayas from Assam westward. The Assam Hills extending at right angles to the inflow of moist air from the Bengal Gulf are deluged by some of the heaviest precipitation in the world. The precipitation diminishes northwestward in the Ganges Valley to the Punjab as the distance from the sea increases, but remains relatively high along the slopes of the Himalayas and penetrates the northwestern provinces, and even the Khyber Pass into Afghanistan. The lower Indus, the very center of the Asiatic low pressure area, is desiccated by dry winds from the Near East or the parched expanse of India itself, and the amount of rain is very small, less than five inches in the form of intermittent showers. In the section of light rainfall, the summer temperature continues high, more than an average of 90 degrees, but for the rest of India, the increased rainfall and cloudiness reduce the average temperature considerably, even to less than the temperatures of May.

In October when isolation decreases

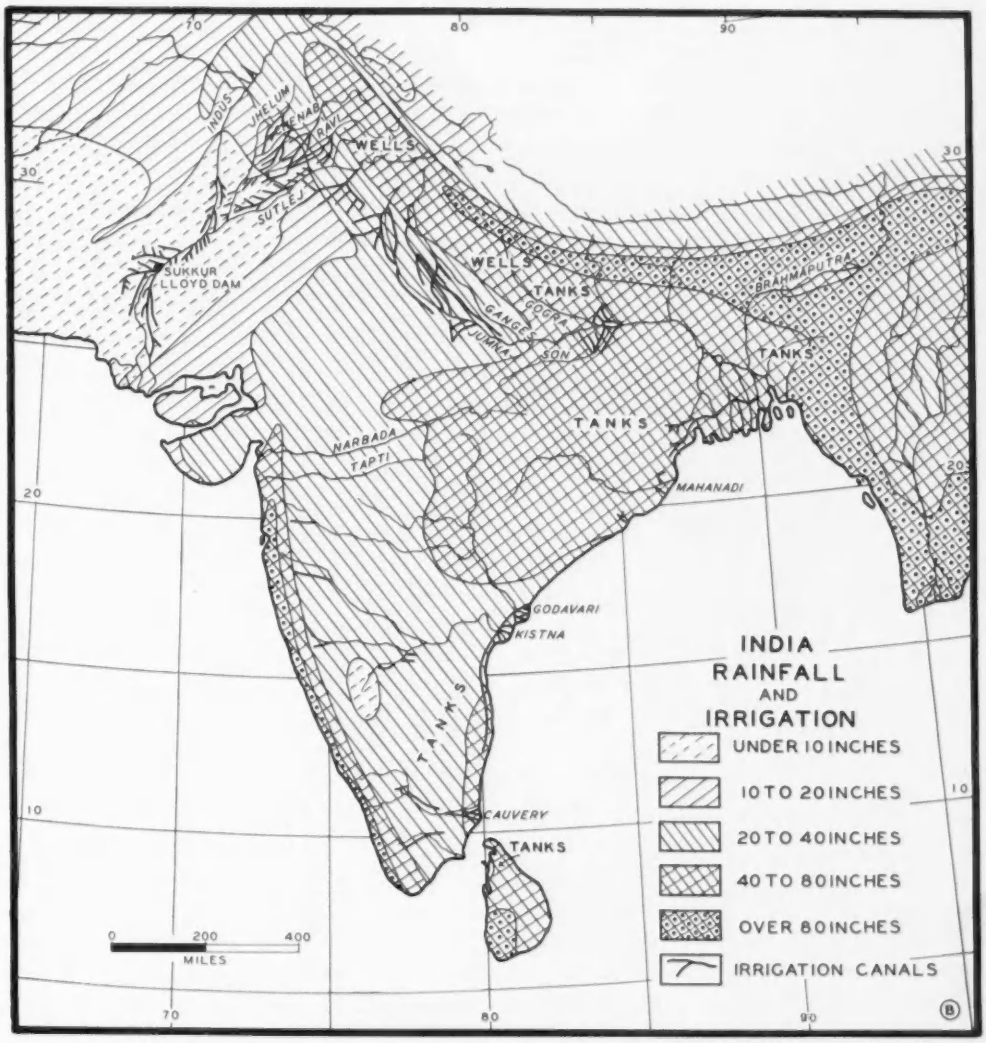

FIGURE 2.—The relationship between the relief and the rainfall of India and the surrounding bodies of water is revealed as the fundamental influence in the character of the agriculture and the distribution of the various types of irrigation. (After Sion "L'Asie des Moussons.")

the monsoon retreats. The brief period of transition continues unpleasant and uncomfortable because of high humidity, but the winter monsoon soon brings relief. Over the Gulf of Bengal the cool air from the continent debouching upon the hot stagnant air over the sea produces tropical cyclones, less intense than those formed over the Pacific but powerful enough to produce considerable rain on the southeast of the Deccan Plateau in the neighborhood of Madras to give that region its rainy season. Because it lies in the wind shadow of the southwestern monsoon, it does not share significantly in the rainy season which that wind produces in other sections of India.

Response to the Climate

The character of India's climate determines the character of India's

agriculture. The amount, distribution, and variability of rainfall play the most important rôle. Figure 1 reveals the close relationship between the rainfall and the agriculture in the rapid decrease of the percentage of cultivated land on the semi-arid and arid regions of the lower Indus where break of the monsoon causes complete ruin of the summer crops in many sections; an early retreat destroys the winter crops which must depend for their early growth upon the moisture remaining from the monsoon precipitation of early spring. Excessive rain results in

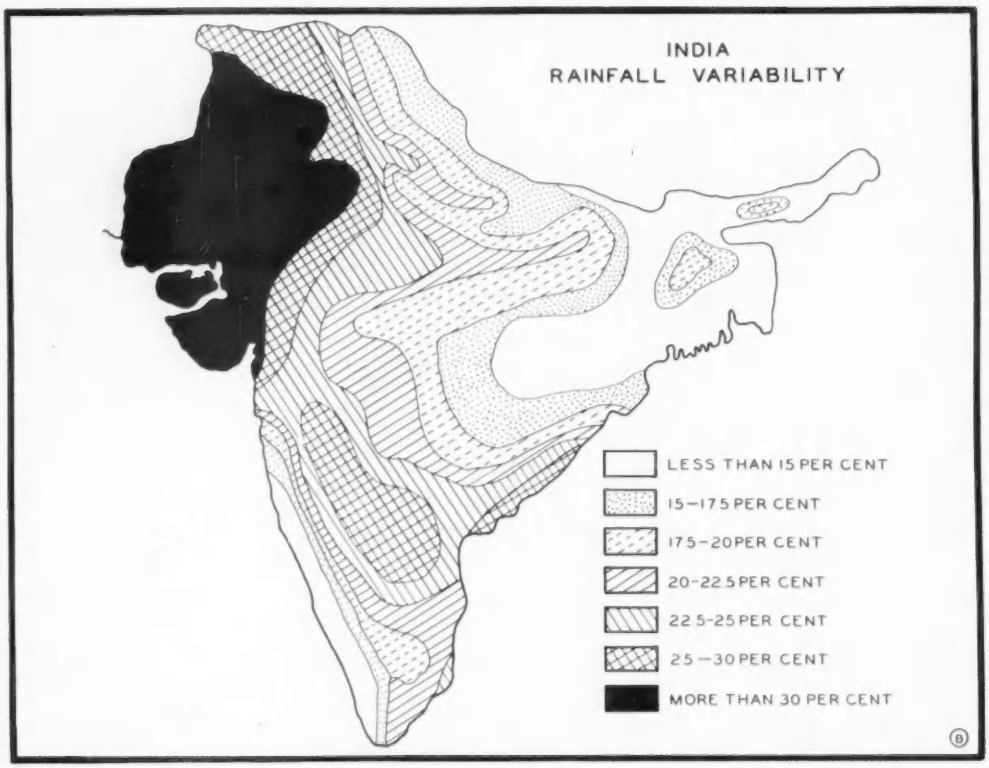

FIGURE 3.—The variability of rainfall in India sets the ultimate limits for crop agriculture, for it is the years of deficient precipitation that cause crop failure and consequent famine, and determine over vast areas the possibility of crop agriculture. (After Williamson and Clark "The Variability of the Annual Rainfall of India," *Quarterly Journal*, Royal Meteorological Society, 1931.)

irrigation provides most of the water for the crops raised.

Recent increase of agricultural population and resultant demand upon the land for food has placed Indian agriculture in such a critical position that any adverse change, even the slightest, in the seasonal distribution or amount of rainfall, seriously affects the welfare of the whole country. A slight delay in the damaging floods along the rivers which change their courses in many places, and, while the damage done is partly compensated for by the fertile layer of silt deposited as the flood subsides, they often leave ruin in their wake. Inadequate rain causes failure of those crops which require for their maturity at least the average rainfall. The time and amount of the northern winter rains

determine the extent of the harvest of the winter crops.

Figure 3 of variability of precipitation indicates the significance of the influences just mentioned. Like all maps of variability, it reveals the increase of variability with decreasing rainfall, but it also indicates how distinctly untrustworthy is the concentrated rainfall like that of India in contrast with a generally distributed rainfall.[2] The significance of this variability of precipitation is further revealed in the treatment of the various agricultural regions of India later on in this study, but its importance is already self-evident.

The importance of the climate is further emphasized in the annual loss of soil and soil fertility as a result of the heavy downpours. To realize the vast quantity of fertile soil washed into the seas during every rainy season, one must have seen the coffee-brown, molasses-like flood waters of the Indian rivers at their time of flood. The heavy rains come too fast to soak into the soil, and their water must be carried away on the surface. Careful drainage to expedite the flow of water along prepared channels reduces erosion and the removal of fertility, but it does not help to accumulate a reserve of water in the soil, so sorely needed after the rainy season has passed. Reforestation on the unused mountain divides, now in most places denuded of any kind of woodland growth, will help immeasurably in retarding erosion with the added advantage that it will provide more timber in a country where fuel is generally scarce and cowdung more valuable as manure must be used instead. With all the effort made to prevent it, soil erosion still is, and probably will long be, one of the chief problems of the Indian agriculturalist.

Where millions of people are so directly affected by unfavorable climatic conditions, tragic famines characterize the national economy and form catastrophic features of the national history. Modern methods of relief are unable materially to reduce the hazard, or ameliorate the effects, of drought and famine. The famine "danger zone" as depicted in Figure 4 comprises chiefly regions with a limited amount of precipitation. Free from famine hazard are the west coast of the Deccan where rainfall is always abundant, and the lower Ganges-Brahmaputra valley and the Chota Nagpur Mountain massif; and curiously enough also the Indian desert, where the use of the land has been nicely adjusted to the arid conditions. The famine zone forms a broad belt stretching northward through the Deccan Plateau toward the Punjab, a belt in which the prosperity and welfare of the peasant as well as his life itself, depend upon the trustworthiness of the rainfall.

A brief résumé of economic conditions in India during the period 1865–1920 reveals the effect of variability and untrustworthy rainfall conditions:[3]

1865 Drought consequent upon the early retreat of summer monsoon followed by low precipitation the next year resulted in the death of one million people in Orissa, one-third the total population.

1866–1869 Delayed summer monsoon prevented proper cultivation of the fields and an early retreat of the monsoon ruined the remnant of crops in the fields.

[2] From "The Variability of the Annual Rainfall of India" by A. V. Williamson and K. G. T. Clark, *Quarterly Journal*, Royal Meteorological Society, 1931.

[3] From "*Vorder und Hinter India*" by Hans J. Wehrli, in Andree's "*Geographie des Welthandels.*"

In these years one and one-half million people and three million cattle died.

1896–1897 Drought conditions extended the limits of the famine zone to include 300,000 square miles and 90 million people, the farthest extension of the famine zone.

1918 Summer rains were inadequate and delayed, ruining the rice and wheat crops. As a consequence of insufficient food, the population was debilitated and the incidents of fatality in the influenza epidemic much increased.

1920 Early retreat of the monsoon resulted

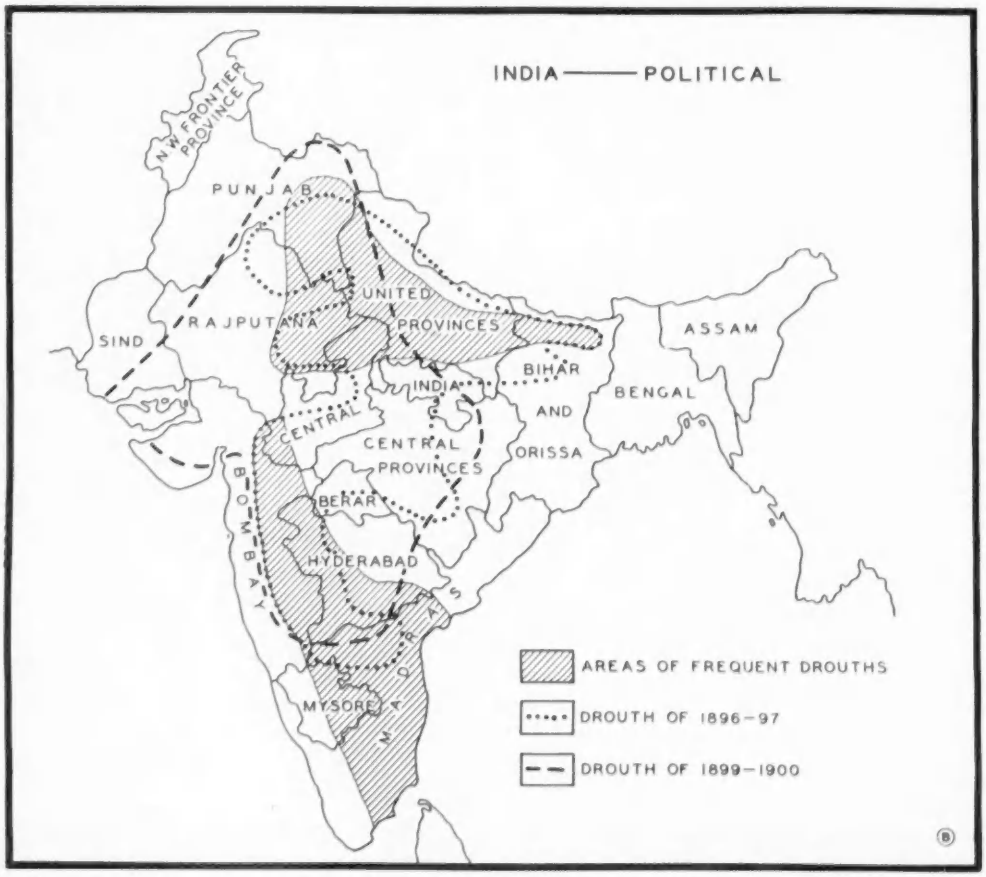

FIGURE 4.—The tragic drouths of India, with their consequent failure of crops and the death of millions of people and their cattle, have characterized her history. Again and again, India has suffered from excessive aridity in occasional periods when the normal distribution and quantity of rainfall have not favored the land. (After Wehrli "*Vorder und Hinter India*," in Andree's "Geographie des Welthandels.")

1899–1900 The weak development of the monsoon yielded inadequate rainfall in western India and by June the monsoonal rains had ceased in many sections. All crops, not irrigated, were lost, and the major part of the livestock starved. The drought area extended over 200,000 square miles and affected a population of 28 million. In one district of the Punjab 92 per cent of the livestock died, and in Gujarat similar conditions prevailed.

in a 40 per cent decrease in the crops of the Punjab district.

Irrigation

Irrigation (see Figure 2), if adequate and trustworthy, solves the problem of deficient or uncertain precipitation. Of India 60 million acres, or one-fifth of the total area, of crop land are irrigated. Table 1

displays the effect of irrigation, for it indicates the total irrigated area in each province and the part of the total area it embraces, as well as the same relationships for the major crops. Further elaboration of the influences and relationships revealed by the table is given in the following discussion of crops and their distribution, but the significance of irrigation in Indian agriculture is obvious.

More than half the irrigation is provided by canals, especially satisfactory on the lowland plains of the Indo-Ganges depression, and the Deccan coastal plains. The Punjab, which enjoys a long duration of rainfall, except along the Himalayan piedmont, owes its present ranking position in agriculture to its marvelous system of perennial irrigation canals which have extended crop production far into the region of earlier extensive stock raising and negligible dry farming. The so-called triple canal system of the Jhelum, for instance, is a triumphant engineering achievement of the first magnitude.

"The underlying principle of its construction is the diversion of the comparatively large winter flow of the River Jhelum as an aid to the scantier winter flows of the Chenab, the Ravi, and the Sutlej, to its east. High up the Jhelum a canal takes off from the left bank and flows along many miles of hill slopes and across the doab on which it irrigates about 345,000 acres of land; but this is merely incidental for the bulk of its flow, which reaches a maximum of about 8,500 cubic feet a second, is discharged into the Chenab on the right bank and withdrawn a few miles farther down on the left bank to supply the Lower Chenab System, an older system of over two million acres. This transfer from the Jhelum for the benefit of the Lower Chenab System permits the withdrawal of an equivalent amount of water at a point farther up the Chenab, to irrigate the doabs between Chenab,—Ravi and across the Ravi. The canal which takes in this water is the largest perennial irrigation canal in the world, with a flow of 11,700 cubic feet a second. It irrigates the Upper Chenab system, an area of 600,000 acres and by an immense level crossing of the Ravi, it sends on nearly 7,000 cubic feet a second at full flow to irrigate a million acres in the doab south of the Ravi."—From "India as a Producer and Exporter of Wheat," page 331.

The Sukkur Dam, on the lower Indus, opened in 1932, has an irrigation capacity of 5 million acres, replacing and extending a former extensive, but inferior, system of flood canals. The region between the Djumna and the Ganges Rivers, and the Son River valley, have been improved and benefited by modern irrigation canals. Irrigation materially extends and improves agriculture on the eastern side of the Western Ghats, but it plays a much more important rôle on the eastern coastal plains where the deltas of the Cauvery, the Godavery, and the Kistna, are sufficiently watered to permit the most extensive cultivation and production.

Wells rank second as sources of water for irrigation. They are of dominant value on the Indo-Ganges plain with its vast storage of artesian water. Some wells are relatively permanent, enduring for many years, but many are only temporarily dug to water-bearing strata near the surface in time of need.

Tanks characterize the Deccan

TABLE I

STATISTICAL SUMMARY OF INDIAN AGRICULTURE, 1926–1927

PROVINCES *	Total Area Irrigated (Acres)	Per Cent of Total Area Irrigated	RICE		WHEAT		BARLEY	
			Area Irrigated (Acres)	Per Cent Irrigated	Area Irrigated (Acres)	Per Cent Irrigated	Area Irrigated (Acres)	Per Cent Irrigated
Madras	9,007,000	27.0	7,462,000	69.5	3,800	22.2	.....	....
Bombay	4,316,000	12.9	1,228,000	40.8	428,000	23.6	18,500	54.2
Bengal	1,318,000	5.6	1,118,000	5.6	14,000	10.8	2,500	2.6
United Provinces	10,316,000	29.5	401,000	5.3	3,746,000	55.2	2,094,000	50.0
Punjab	13,679,000	51.1	645,000	72.9	5,046,000	53.7	262,000	34.1
Bihar and Orissa	5,301,000	21.3	3,586,000	25.5	266,000	22.5	102,500	7.8
Central Provinces and Berar	1,004,000	4.0	846,000	16.0	50,000	1.3	1,500	15.3
Assam	452,000	7.5	441,000	9.4	.....	....	.....	....
Northwest Frontier Provinces	935,000	44.6	41,000	99.9	334,000	33.4	72,000	45.8
Ajmer-Merwara and Manpur Pargana	118,000	33.7	137	20.4	17,000	73.9	33,000	62.2
Coorg	3,500	2.1	3,500	3.5	.....	....	.....	....
Delhi	47,000	21.6	18	18.0	19,000	38.7	4,000	22.2
Total	46,496,500	22.3	15,772,155	23.8	9,923,800	41.1	2,590,000	40.5

PROVINCES *	JOWAR OR CHOLUM (Great Millet)		BAJRA OR CUMBU (Spiked Millet)		SUGAR CANE		COTTON	
	Area Irrigated (Acres)	Per Cent Irrigated	Area Irrigated (Acres)	Per Cent Irrigated	Area Irrigated (Acres)	Per Cent Irrigated	Area Irrigated (Acres)	Per Cent Irrigated
Madras	493,000	10.6	322,000	9.6	111,000	96.4	192,000	8.2
Bombay	728,000	8.5	614,000	10.5	68,500	100.0	354,000	7.7
Bengal	.....	....	.....	....	33,000	16.5	2,500	5.0
United Provinces	38,000	1.7	3,000	.1	1,156,000	71.6	299,000	37.5
Punjab	181,000	18.3	266,000	11.0	362,000	80.8	2,271,600	89.9
Bihar and Orissa	3,000	3.1	600	.8	185,000	64.0	3,000	3.7
Central Provinces and Berar	.....	....	.....	....	22,000	95.6	.....	....
Assam	.....	....	.....	....	.....	....	.....	....
Northwest Frontier Provinces	14,000	26.4	6,000	4.9	53,000	100.0	22,000	95.8
Ajmer-Merwara and Manpur Pargana	2,000	2.7	2,000	5.4	200	47.5	22,000	50.0
Coorg	.....	....	.....	....	.....	....	.....	....
Delhi	.....	....	.....	....	6,000	86.5	2,000	50.0
Total	1,459,600	7.1	1,213,700	8.8	1,996,700	69.9	3,158,150	20.7

* For Provinces see Fig. 4. Native States are not included.

Plateau beyond the boundaries of the black cotton soils regions. They are storage pools filled during the rainy season, for which the water is utilized in the dry season for irrigation. The tanks remain dry when no rain falls.

PRINCIPAL CROPS OF INDIA

The crops of India may be divided into two major groups, summer crops and winter crops. The summer, or better, autumn crops, called "kharif" by the natives, grow through the high temperatures and monsoonal rains of summer and are harvested in autumn. Winter crops, called "rabi," grow by the moisture left by the monsoon upon its retreat, and by the periodic winter rains in northern India. Because the winter temperatures are relatively low and approach summer temperatures of lands of higher latitudes, the rabi crops are crops of temperate lands in contrast with the distinctly tropical kharif.

The division into kharif and rabi crops is not significant in southern India where temperatures vary little during the year, and the contrast between the wet and dry seasons is less pronounced. The crops which are solely kharif in northern India may be grown throughout the year in southern India. Some crops, like

sugar cane, grow during the whole year, and thus do not fall into either the kharif or rabi group. Some varieties of a crop may be grown as kharif because they are adapted to summer conditions, while other varieties of the same crop may be grown as rabi, because they are better adapted to winter conditions.

Crop rotations that include both kharif and rabi crops are practiced for most of India, but a fallow period is nearly always made part of the rotation. Even in the irrigated parts, the soil needs rest, without which the fertility decreases even under the most careful intensive irrigation. In general the kharif crop is followed by a prolonged fallow period, after which a rabi crop succeeds in the next year to be followed by another fallow period of shorter duration, thus completing the rotation cycle. Leguminous crops to maintain fertility play a prominent part in the regular rotation and in the rather limited number of cases where a second crop is grown without fallow, the second is usually a leguminous cover crop. Although the acreage yields of Indian crops are not likely ever to be very high because climatic conditions favor a short growing season, better agricultural methods and fertilizing practices should materially increase production. It is to this end, and to the planting of better seed, that most of the agricultural research is devoted.

KHARIF CROPS

Rice, the principal crop of India; jowar, the staple food of the agricultural population of the Deccan Plateau; bajri, another millet crop; ragi, still another millet crop; corn or maize, an introduced food crop; and cotton, the great textile and commercial crop of India; these constitute the significant kharif crops of India.

Rice

Rice, the main crop of India, occupies 80 million acres, one-fourth of the cultivated area. Its distribution is limited by the 50-inch rainfall line except for some irrigated sections like those along the lower Indus, the northwestern provinces, and the river deltas of the middle east Deccan coast. Nearly everywhere that rice grows, it forms the main crop as a comparison of the maps of rice occupancy and of dominating food grains show (Figs. 5 and 6); the line separating the regions where rice is the main crop from the regions where other crops are dominant almost coincides with the limit of rice production. Irrigation is of minor importance in rice cultivation except in the regions just mentioned, for only slightly more than one-fifth of the total rice acreage is irrigated. Bengal with its heavy monsoon rains is India's rice region, *par excellence*, and in most of the Bengal lowlands, rice is the only food crop. This dominance of rice in Bengal would have been more conspicuous on the map of crop occupancy (see Fig. 6) if the commercial crops like jute in the delta and tea in the Brahmaputra valley had not decreased the percentage of cultivated land in rice. Rice is a one-year crop, followed by fallow to the next summer except in a few advantageous sections in southern India where two, or in places even three, crops are produced annually. Winter crops, in general, do not immediately rotate with rice but are separated from it by a fallow season; in most cases, however, rice is the one and only crop. Because Bengal, with its 20 million acres of rice, looms as the fore-

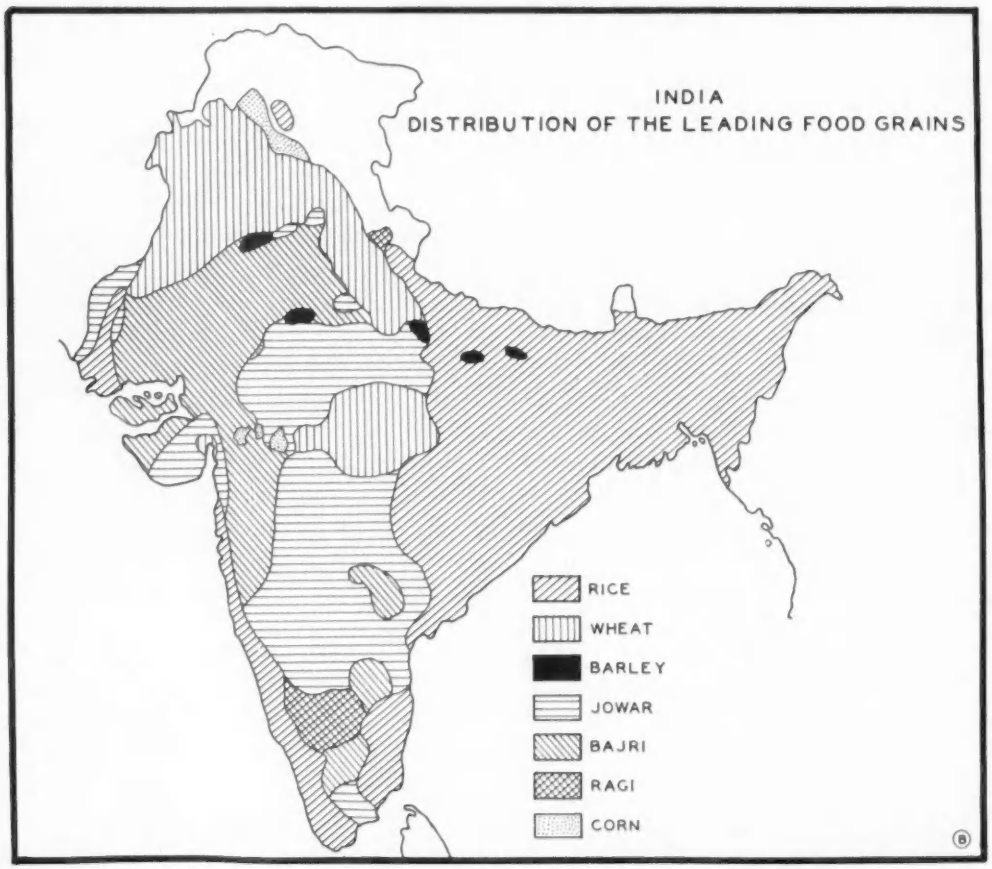

FIGURE 5.—The occupancy of the land in India by the leading food grains is clearly portrayed by this map of their dominant distribution, and reveals in large measure their adaptability to the quantity and distribution of rainfall, as well as to the character of the soil. Rice, wheat, jowar, and bajri constitute the four leading grains so far as area of dominancy is concerned.

most rice-producing region of India, it may be discussed as an example.

Three distinct types of rice may be recognized, each comprising innumerable varieties: the *Aman* or summer rice; the *Aus* or autumn rice; and the *Boro* or winter rice. The *Boro* rice yields most heavily, but it occupies only two per cent of the total rice area. It is limited to low lying fields into which it is always transplanted where water is always available. Transplanted from the small nurseries in February, it is harvested in May. Since it requires high winter temperatures for its growth, it is limited to the southern sections and is absent in the colder middle section of the Ganges plain. *Aus*, which occupies one-fourth of the rice area is generally sown broadcast, and its yields are the lowest of the three types. Its advantage lies in its quick ripening and its adaptation to local rain conditions; and its season of harvest in early fall enables the farmer to plant a second crop which is a rabi crop like rape, mustard, or some variety of pulse. *Aman*, however, is the main type grown and occupies most of the rice area. It may be transplanted onto the flooded lowlands or the seed may be broadcast before the flood covers the fields. It

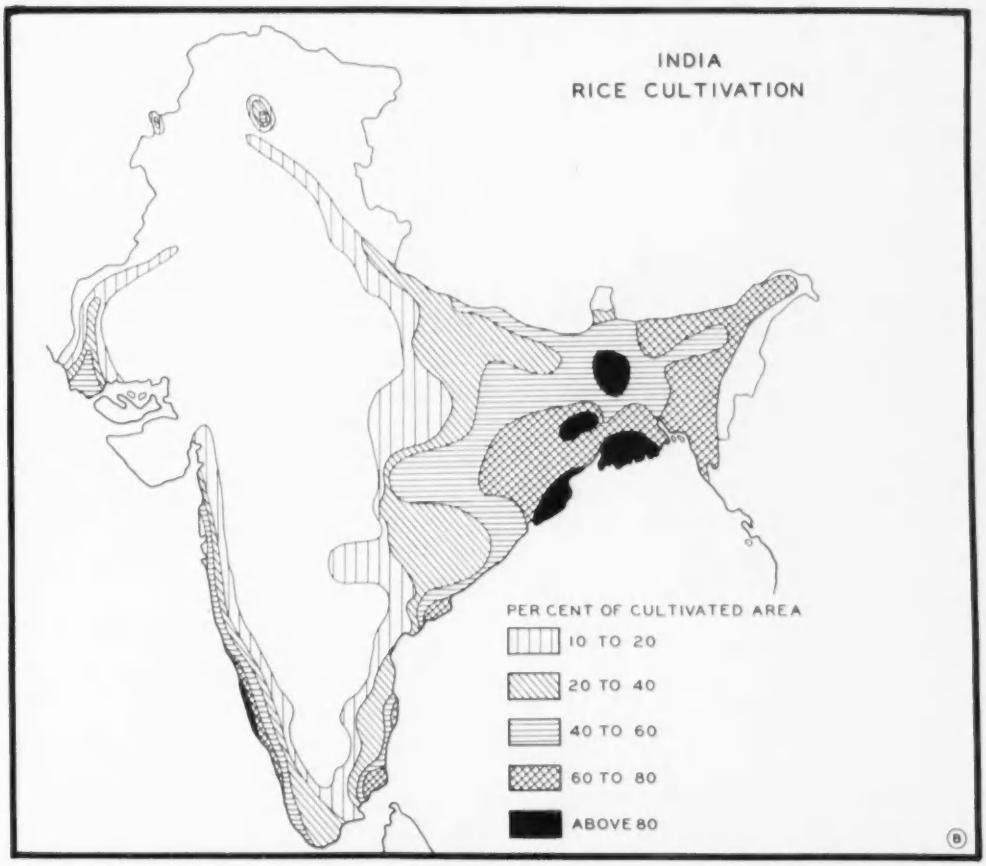

FIGURE 6.—The intensity of the occupancy of rice on the land where it is cultivated is a function of the quantity and character of the moisture available, and the areas of rice culture indicate by their intensity where conditions are most favorable for this grain as compared with other grains of India.

ripens slowly and stands in the field when the flood retires until the harvest in December.

Engelbrecht describes the difference between the rice culture on the higher river levees with their lighter soils where early ripening rice is grown to be followed by a rabi crop after it is harvested and on the heavier clay soils on the lower land back of the levees, which is flooded during the transplanting of the later ripening varieties, and from which the growing crop can draw enough moisture to fill the grain well for the harvest at the end of the year. In Behar and the United Provinces westward of the Bengal rice area, the late-ripening rice is limited to the lower generally irrigated portions of the Ganges plain, and to the slopes of the Himalayas where rainfall is more abundant, but throughout these regions the early-ripening rice becomes dominant in contrast with Bengal. The map (see Fig. 6) reveals the interesting correspondence between the rice acreage and the higher rainfall, particularly in its westernmost extension along the Himalayan front. Though rice is also found in the far western mountain valleys, and in the fertile plain of Kashmir, maize, growing on the slopes, replaces it generally as a principal food crop.

Rice remains the only grain crop on the coast of Orissa and into the valleys of the forested Chota Nagpur Mountains, where the rainfall exceeds 50 inches. South of the Mahanadi Delta, where the rainfall decreases, rice would yield second place to jowar, but for the irrigated delta of the Godaveri and Kistna where rice dominates the area in summer. South of these deltas, rice does surrender its ranking position to millet, but about Madras, the increased fall rains again raise rice to first place. Here, however, the fall rains modify the rice season and shift the harvest accordingly into the winter. On the Cauvery Delta, nearly entirely irrigated, an early rice crop is locally harvested in September to be followed by a late rice crop ripening in winter. Over most of the delta only one crop is customary—a late-ripening crop with its harvest in February; the early crop is limited to the western part, which receives more copious rainfall from the regular southwestern monsoon through the Palghat Gap.

Rice is also the main crop on the western coast. Conditions vary widely in accordance with the date of the beginning, and of the duration, of the rainy period. Where the Tapti cuts the coast north of Bombay, the decreasing rainfall forces rice into a subordinate position to wheat and millet. On the plain of Gujarat, rice is limited to the low areas where water collects. The method of preparing the seedbed by burning along the Bombay coast is most interesting:

"Typically the procedure is first to cover the prospective seedbed with a layer of cowdung broken into small pieces; cover these with a layer of branches, twigs, grass or any other combustible material; cover this with a layer of soil and burn. The burning is done shortly before the rains are expected. After the rains soften the ground, it is ploughed, cross-ploughed, and cultivated again and reduced to the smooth and even texture characteristic of good rice seedbeds and then planted. The time for transplanting is said to be about 20 days later. At this time the seedbed, as well as the other land, receive transplanted rice and the seedbed produces the finest crop which is saved for seed."—From "Rice" by E. B. Copeland, Macmillan, London, 1924.

The advantage of the method accrues from the killing of all the weeds by the burning, so that the young rice can grow during the first heavy rain period in complete monopoly of the soils.

Finally the rice districts of the Lower Indus and the Indus delta, made possible by the river floods, complete the list of rice areas. Some varieties of rice can be grown even in brackish or saltwater during the early part of their growth to be watered by fresh river water afterward, thus permitting the growing of an early crop; but most of the rice is watered by the regular summer floods. The Sukkur Dam will increase the rice acreage appreciably, though part of the additional irrigated area will be used for wheat and jowar.

Jowar

Jowar, or great millet, forms the staple food of the agricultural population of the Deccan Plateau and its foreland. It is a valuable fodder for cattle. It occupies from 35 to 40 million acres. Because it grows well on fertile soils watered by moderate rainfall (20 to 40 inches), it is very

well adapted to the regur soils. Essentially a summer crop, it is also grown in winter on the region about the Gulf of Cambay and south of a line across the peninsula a little north of the Godavery River. Enpancy (see Fig. 7). It is dominant as a grain crop throughout a zone extending north and south between the Western Ghats and the semi-arid Rajputana on the west and by the line of 50-inch rainfall on the east

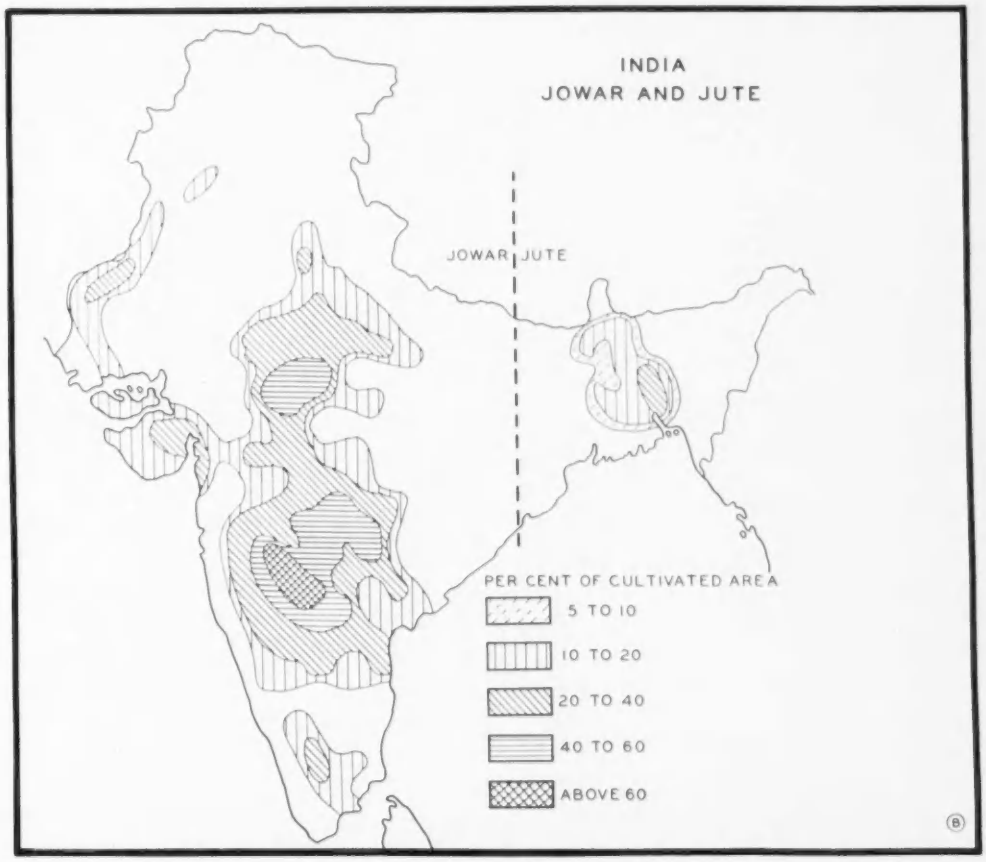

FIGURE 7.—Jowar, or great millet, the staple food of the agricultural population and the fodder for cattle of the Deccan Plateau and its foreland, occupies from 35 to 40 million acres, growing best on well-watered fertile soils. Jute is so nicely adjusted to the Ganges-Brahmaputra Delta that this region monopolizes the jute industry of the world.

gelbrecht has shown the line to be the northern limit of 67 degrees for the coldest month with an average minimum not lower than 51 degrees. The water retentivity of the regur and the more regular distribution of rain southward permit winter growth. The importance and distribution of jowar are clearly presented on Figure 5, as well as the map of crop occu-

where rice is able to displace jowar as the main crop. As rainfall conditions would indicate, a zone of jowar extends around the Gulf of Cambay in Gujarat between the limits of copious wetness and excessive aridity. In the Madua region toward the south, the extension of jowar as the leading grain is rather limited though it has a special value as fodder. Its

area of dominance is bordered on both sides by rice regions and toward the north because the rainfall diminishes beyond the optimum for jowar, it is replaced by bajri first and then by ragi, the main crop of the cooler Mysore uplands.

North of the gap of Palghat, it resumes its ranking position, and in some districts occupies as high as 70 per cent of the cultivated area. Where poorer soils characterize the eastern section, bajri gains acreage and surpasses jowar in importance. Two factors determine the decline in relative importance of jowar in the zone from Bombay to the central provinces: (1) the high acreage planted in cotton (see Fig. 8 for crop occupancy of cotton) and (2) the adaptability of the regur soils to wheat as a winter crop. Northward in the central provinces jowar regains its leading position as a food grain though less definitely than in its southern center; and finally gives way to rice and wheat in the Ganges plain.

On the rich black soils about the Gulf of Cambay jowar rivals wheat in importance; on the Kathiawa Peninsula jowar loses its importance as compared with bajri. The region of jowar importance between the wheat and rice districts of the Indus region is consequent upon irrigation.

Bajri

Bajri, or spiked millet, is inferior to jowar both in its value as a food grain and as a fodder, but its demands upon its environment are so much less exacting than jowar, that it has attained an enviable prominence on an acreage of 20 million acres where other millets fail. It is rarely irrigated. It forms the principal crop, and often the only crop in the semi-arid regions about the Indian Desert where temperatures are high and precipitation slight. Though relatively it possesses a high value on such semi-arid lands, its absolute importance is limited by the very low percentage of the area cultivated (compare Figs. 1 and 5). In the semi-arid regions it is sown early in summer when the rainy season begins. The rare showers afterward are generally sufficient to mature the crop, but the yield is low; however, the yield can be doubled wherever irrigation is possible.

Beyond the semi-arid regions bajri continues the principal food grain southward in the rain shadow of the Western Ghats where it interrupts the dominance of the jowar in the Deccan Plateau and on the Gujarat lowlands. Where it occupies first place on the Deccan Plateau, bajri grows wherever the soils are lighter and not suitable for jowar or where the rainfall diminishes as in southern India south of the Palghat Gap. It holds an importance supplementary to jowar as ragi holds toward rice and barley, towards wheat wherever growing conditions are somewhat unfavorable.

Ragi

Ragi occupies from 6 to 7 million acres and rises to a position of major importance as a food grain on a rather limited area of the southern Deccan (see Fig. 5). Like jowar and bajri, it is a millet, but it requires a climate more like that favorable to rice; but unlike rice, it can grow upon infertile soils. Consequently, it plays no part in the economy of the fertile alluvial lowlands, but replaces rice on the southern Deccan upland where rainfall is heavy and fairly well distributed. It also grows well on the

Madras hinterland where the moisture received through the Palghat Gap and from the retreating monsoons waters the soils adequately. Irrigated rice is grown in the valleys, but unirrigated ragi covers the uplands and forms the food for the poorer classes of the population. One other area (see Fig. 5) is dominated by ragi as the principal food crop, that is, a Himalayan district along the foot of the mountains just west of the rice area, where ragi replaces the rice where moisture conditions are less favorable.

Corn

Corn, or maize, like ragi and barley, can be considered of only secondary food importance in India though it occupies a cultivated area of about 8 million acres. Probably introduced by the Portuguese and thus being a relatively late immigrant in this land of ancient agriculture, its extension is only partly geographic, and not yet adjusted in its distribution to the areas best adapted for it. It achieves its chief importance in some of the northern mountain areas where the summer rains are adequate and regular, but where there is little level space for the cultivation of rice. For the same reason it becomes the principal food in a limited portion of the northwestern Deccan north of the Narbada Valley, but it attains principal importance in the Himalayan Mountain massif (see Fig. 5). In the mountain regions of the Punjab and the northwestern provinces, corn assumes its wonted significance as a warm temperate crop and provides the main food for the mountain peoples, except in the level Kashmir basin and along the flat valley bottoms. Though it occupies a much greater acreage along the Ganges plain, corn is relatively of less significance there. Planted in the early rainy season, it may be harvested in early fall, and wheat or barley may follow as a second crop. Thus it gains an advantage over rice, and its distribution in most districts coincides with the double-planted croplands. Except in the Punjab, it depends for its growth on local rains, and only slightly upon irrigation.

Cotton

Cotton constitutes the great textile and commercial crop of India. It occupies an area of about 25 million acres, and so ranks immediately after rice, jowar, and wheat in cultivated area. It comprises one-fourth of the world's cotton acreage, but only one-sixth of the yield for the great economic handicap of the Indian cotton culture is its relatively low yield, a disadvantage emphasized by the short staple of its fiber. The short staple is an ecological adjustment to the Indian climate with its brief period of rain and the consequent necessity of rapid-growing cotton varieties. Foreign varieties introduced into the land succeed only where cotton is irrigated, and the growing season lengthened, as in the Punjab and the Sind, or where the rainy season is prolonged as in the southern Deccan with its fall rains. Improvement in the main cotton districts has been sought by bettering the native cotton varieties rather than by introducing maladjusted foreign types.

Cotton demands growing conditions similar to those for jowar; rich, rather heavy soils and moderate rainfall—not above 40 inches. Generally, cotton requires six months for growth under temperatures between 65 and 80 degrees. As a kharif crop based upon the summer rainfall, its

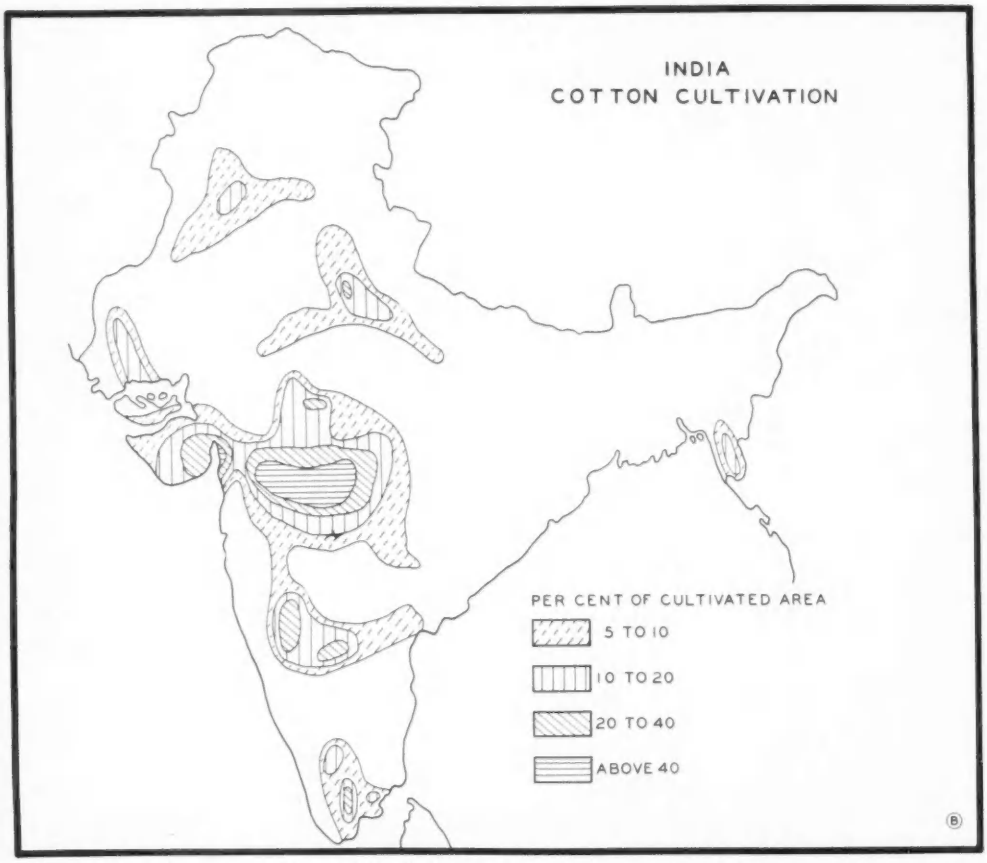

FIGURE 8.—The cotton culture of India is distributed over several widely separated tracts from the southernmost tip of the peninsula to the northwestern provinces, with a small area on the eastern boundary. Its maximum production is upon the black regur soils of the Deccan.

harvest extends well into the winter season with frost as a hazard only in the northern section. Heavy rain or wind at flowering or fruiting harms the bolls considerably and reduces the yield. The main cotton regions are well indicated upon the map of crop occupancy (see Fig. 8). The Punjab and Indus cotton districts are almost entirely dependent upon irrigation (see Table 1). Perennial water supply extends the cotton-growing season appreciably, and it is in the region of the Punjab where this is available that American cotton varieties have most notably succeeded. Planted in March the cotton is picked in October and November. Along the lower Indus where the flood canals function only during the summer high level of the floods, the growing season is limited, but Sukkur Dam may provide conditions of ample water supply like those of Egypt and the Anglo-Egyptian Sudan, where the temperature is also similar.

In the cotton districts of the United Provinces, cotton is still partly irrigated, as is also true more particularly in the adjoining cotton region at the foot of the Arravalli Hills; but over most of the area cotton culture depends upon the rainfall. The area is limited northward and eastward by excessive rainfall for more than five inches in June and more than ten

inches in August makes cotton cultivation in this section unprofitable.

The cotton district about the Gulf of Cambay coincides with the jowar and wheat regions. Its fundamental requirement is fertile black soils. It is limited southward by the extent of the 40-inch rainfall and it fades out toward the west and north because of aridity. The conditions for cotton growing about Cambay are so favorable that the longest stapled cottons of India are grown in this region, where the rainfall is higher than on the Deccan Plateau, and the growing season longer.

The most important cotton region of India lies on the black soils of the northern Deccan. Though shown on the map of crop occupancy (see Fig. 8) as one continuous area, it is in reality very much broken and of far greater complexity than the map indicates. The cotton is segregated in the fertile valleys, separated by ridges of thin, poor soils where bajri, the crop of less fertile soils, replaces the cotton-jowar or cotton-wheat rotation of the valleys. The cotton itself is short staple, the so-called *Oomras*, an adjustment to a short rainy season of moderate precipitation. Along the eastern foot of the Western Ghats, this region connects with the next in importance where cotton is grown on the regur soils of the Madras Deccan as well as on the red soils of Dharwar. The fall rains become so important a factor in this region by shifting the growing season that cotton almost becomes a rabi crop. Short staple characterizes the Madras Deccan, but American cotton succeeds in Dharwar on the red soils because of the favorable marine influence exerted through the lower Western Ghats and because of the better-developed irrigation.

The last of the Deccan cotton regions lies on the extreme south in the rain shadow of the Travancore Mountains where the crop is concentrated chiefly on the fertile tracts of regur and watered by the evenly distributed rains, the region of the famous Tinevelly cotton which forms the highest class export cotton for the English market. The small cotton region on the border between Assam and Burma grows its cotton during the early part of the year, watered by the spring rains; and the harvest comes before the beginning of the heavy summer rains.

Sugar

India boasts the second largest acreage of sugar cane of the world—3 million acres or more. The yields, however, are small. Java, with an acreage of only one-fifth as large as that of India, produces as much sugar, under ordinary conditions. To yield high production, sugar cane must be grown under definite carefully supervised and favorable conditions. The soil must be highly fertile and kept in perfect condition by the right kind of manure or fertilizer in the right amount, if the cane is to grow most advantageously. Even where the amount of rainfall is adequate, irrigation is necessary to provide the proper amount of moisture at the proper time. The soil must be well drained and not permitted to become waterlogged. Regular weeding is necessary. The variety of cane grown must have been carefully determined to meet the local conditions of climate and soil. And finally modern equipment for harvesting and compressing the cane must be provided.

India does not fulfill many of these conditions. In most places sugar

cane is grown as a garden crop by the wealthier peasants, who can afford to devote their fields to the crop for the whole year, can supply the requisite fertilizer, and who can provide the necessary irrigation. The nicely adjusted control of the sugar cane industry found in Java is not possible in India at all. Heavy capital investment in sugar factories is not justified or possible where the methods of crushing cane and extracting the sugar are so crude and primitive as they are in the domestic type of sugar production that characterizes India.

Wherever soils are favorable and irrigation possible, sugar cane is grown over nearly all of India. The regur soils of the cotton district will not grow sugar cane because they cannot be irrigated. Sugar cane is most extensively cultivated on the lowland plains from the Punjab down to the Ganges Delta. The United Provinces are the chief producers, and of the acreage devoted to sugar cane in that region, 75 per cent is irrigated. In this area of concentrated sugar cane culture, increased production is most eagerly sought. The trench system of planting has been extensively advocated, because it is expected to double the yield. One-half million acres in the United Provinces alone have been planted to improve varieties of cane. Modern plants have been built, and the general production cost lowered. By such methods as these, India hopes to increase her production, and eliminate her importation of sugar which seems paradoxical in relation to the favorable climatic and soil conditions.

Peanuts

The most rapid change in Indian agriculture in recent years has been the three-fold increase in the production of peanuts since 1918–1919, for at present India plants six million acres to peanuts and produces 3 million long tons, her chief source of oil within the country. India now ranks as the leading export country for peanuts, even surpassing West Africa, but much objection to the export of such a necessary element in the diet, an element at present lacking in many sections, has been raised, and may eventually modify the disposal of the crop.

The black soils along the east slopes of the Western Ghats and about Madras form the basis for the chief region of production. Peanuts require adequate rainfall and well-drained open soils. Improved varieties with higher oil content and greater immunity from disease despite a shorter growing season and a shorter rainy period have enabled India to grow peanuts northward of these regions, with the result that the central provinces, the Chota Nagpur, and most recently Gujarat, have become important regions of peanut production.

Sesamum

A large country like India, with such a vast population requiring at least a minimum of fat in its diet, must depend upon such vegetable oils as sesamum for parts of its requirements, particularly since butter production is negligible, and coconuts are limited to the humid southern coastal plains. Sesamum, which for a long time had held first place in the fat economy of India only to yield it to peanuts, still retains a great deal of its importance, and occupies 5 million acres of the crop lands. Sesamum is not so exacting in its soil requirements as are peanuts, and thrives on

the lighter soils where peanuts are not successful. Though grown everywhere, it is chiefly concentrated on the northern part of the Deccan Plateau, coincident with the cotton area. It is principally a summer crop, but its many varieties are so nicely adjusted to local soils and climates that it is grown in summer and in winter both. It is planted in the beginning of the rainy season, and harvested in fall. Summer sesamum, like bajri, is grown on light, rather infertile soil, leaving the better soils to cotton and jowar. The much smaller winter crop of sesamum is relatively more productive since better soils can be devoted to its growth.

Jute

Jute occupies an area of about 3½ million acres. In its raw and manufactured forms it represents about one-sixth of the value of India's exports. It is limited to the Ganges-Brahmaputra delta of Bengal and adjoining sections of Bihar and Assam (see Fig. 7). The explanation of its distribution on the delta lowlands and of its maximum acreage in the eastern part of the delta lies in the spring rains typical of the Assam region and over eastern Bengal, which are necessary to the successful growth of jute. Jute is sown in February–March and the plant must be mature before the flood rises over the banks of the streams, for jute dies if water covers more than half the plant. Jute is cut in July–August during the flood season when there is ample water for retting the stalk. In his excellent book "Economics of Rural Bengal," Saha describes exhaustively the method of the harvest. The reaper must stand for hours in three to four feet of water, diving into it every minute or two to reach the foot of the plants with his sickle. The conditions necessary to jute culture are so exacting that only the distinctive Bengal conditions of rain and consequent flood furnish any considerable area where the crop may be grown. As a consequence, jute lends itself to monopoly of land and industry as no other product of the soil.

Tea

Tea ranks high as a commercial crop of India. It occupies an area of 750,000 acres and forms one-twelfth of the value of India's total exports. Tea cultivation is concentrated on four distinct regions (see Fig. 9):

1. Southern India (Travancore and Nilgiri Hills).
2. South of the Shillong Plateau of Assam (the so-called Sylhet and Cachar districts).
3. The Brahmaputra Valley including the region north of the Shillong Plateau (Sibsagar district) and the valley itself (Lakhimpur).
4. The Dooars-Terai region at the foot of the Himalayas extending to the plantations of Darjeeling.

Southern India (12 per cent of production)

As in west Java and Ceylon, tea in southern India has replaced coffee, following the ravages of the diseases which destroyed the coffee plantations in the later half of the nineteenth century. The physical conditions, where tea is raised at elevations between 3,000 and 6,000 feet on the mountains of Travancore and Nilgiri on the west side of the Deccan Plateau, are like those of Ceylon which will be discussed later. The uniform temperatures controlled solely by elevation and the well-distributed rainfall with little or no short dry season constitute the favorable factors for tea production. As in other

equatorial plantation tea production, the estates on the lower slopes yield better, but the quality is not so good as of the tea grown at higher elevations. The Nilgiri Hills mark the northern limit of tea cultivation in this region because farther north the early spring rains are lacking and the dry season is protracted.

The 200,000 acres of coffee production, entirely limited to southern India, is grown under conditions similar to those that make tea possible. In this region the early spring rains are more critical for coffee than for tea because they favor blossoming, on which the total crop depends.

Sylhet and Cachar (21 per cent of production)

In the Surma Valley which forms this district of tea production, the crop grows under the conditions typical of Assam: a mild uniform temperature between 60 and 70 degrees; short, rather dry, winter and long, warm, rainy season; and high relative humidity even during the winter.

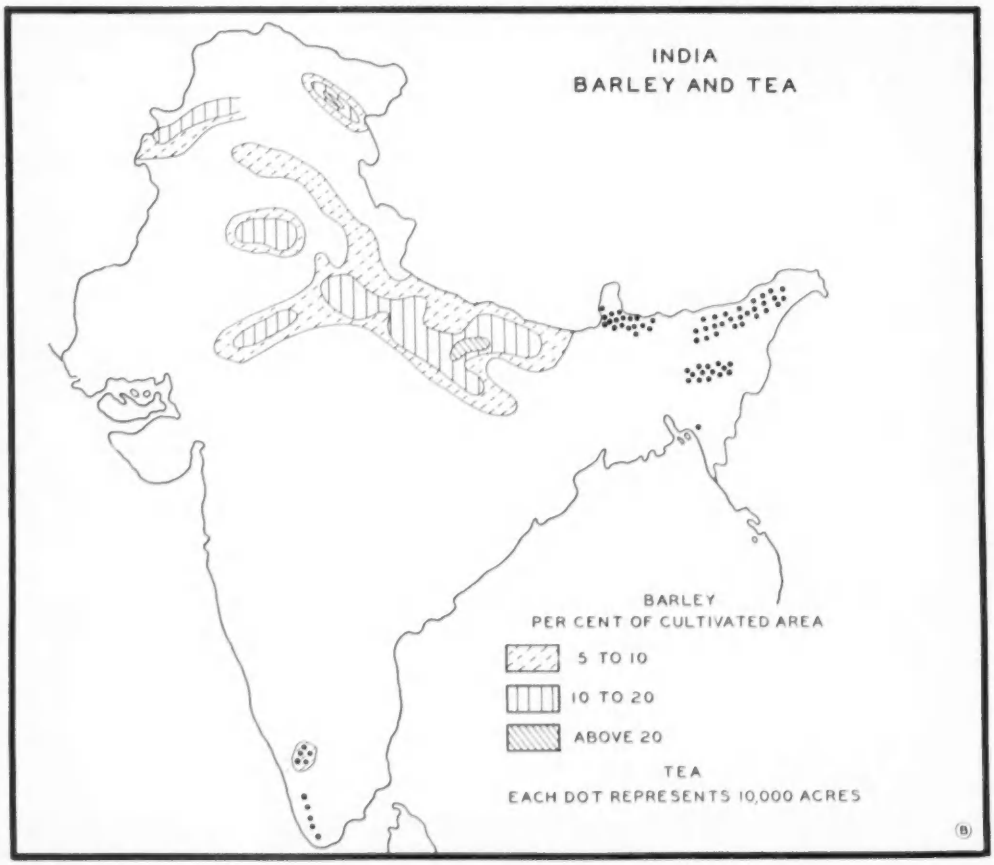

FIGURE 9.—The distribution of barley is relegated to those areas where the other cereal grains will not grow successfully. It ranks second to wheat in importance as a winter or rabi crop, and grows under similar climatic conditions except that its limitations are not so rigorously set. Tea ranks high as a commercial crop of India, and occupies 750,000 acres.

Brahmaputra Valley (40 per cent of production)

India's chief production comes from this region, and the strong Assam teas hold high repute on the

world's market, particularly for blending with more delicate teas of the equatorial regions to give them strength. The winters are slightly colder than in the Sylhet and Cachar districts, but the rainfall conditions are favorable. As in jute culture, the early spring rains are the most important factor, and the limit of their distribution sets the limit for the favorable production of tea, as distinguished from the regular monsoon regions where the rainfall begins much later in the season. In this district tea is a lowland crop, and the green blanket of tea plants mantles vast areas of the valley.

Dooars-Terai Region (19 per cent of production)

The tea of this district closely resembles that of Assam. The rainy season begins somewhat later than in the preceding regions. The tea produced on the Himalayan slopes about Darjeeling (6 per cent of production) at elevations from 1,000 to 6,500 feet differs significantly from those of the preceding regions. The best-flavored tea of the world is grown here, and it receives the highest price on the world market. The cold winter with a January temperature of 40 degrees interrupts the growth of the tea, and when the plantations are covered with snow, they form a rather remarkable contrast to those of more tropical realms. The yield of this district, 359 pounds per acre, is considerably less than the average for all of India, 562 pounds.

This discussion of the tea production of India is derived largely from "Tea in Assam, India" by Clarence Jones, which appeared in the May, 1924, issue of the *Journal of Geography;* and *The Tea and Coffee Trade Journal.*

TABLE II

DISTRIBUTION OF RAIN IN PRINCIPAL TEA PRODUCING SECTIONS
(in Inches)

	Nilgiri	*Sylhet and Cachar*	*Brahmaputra Valley*	*Dooars*	*Darjeeling*
January	2.38	0.64	0.95	0.47	0.80
February	2.32	2.32	1.35	0.74	1.10
March	1.94	7.99	3.59	1.12	2.00
April	4.12	13.56	7.89	3.99	4.10
May	6.00	15.72	9.66	11.09	7.80
June	4.08	20.39	12.43	33.43	24.20
July	4.74	19.98	17.04	44.56	31.70
August	4.33	18.69	13.01	28.21	26.00
September	6.63	13.95	10.11	28.07	18.30
October	14.35	6.40	4.47	7.49	5.30
November	10.16	1.31	0.92	0.98	0.20
December	4.30	0.54	0.37	0.19	0.20
Total for year	65.35	121.49	81.79	160.34	121.70

RABI CROPS

The rabi crops of India play a secondary rôle to the kharif, but they are none the less critical in the agricultural economy of the country. Wheat, barley, and a few other secondary crops constitute this group.

Wheat

Wheat (Fig. 10), which occupies 30 millions of acres of India's crop lands, constitutes her most important grain crop, and among all the crops of India, occupies third place in rank, being less important than rice and millet. Wheat is popular as a food grain and forms an important export. Like rice, wheat constitutes the chief grain crop within its own area of cultivation. The best conditions for wheat are found along the foothills of the Himalayas in the Punjab and the United Provinces where the regular

winter rains are augmented by the moisture stored from the fall rains. Irrigation, upon which more than half of the crop acreage depends, extends the area of wheat production southward, particularly where the perennial irrigation systems of the Punjab rivers and the Jumna-Ganges district provide the water.

In most of the sections of this district, wheat is sown a few weeks after the withdrawal of the summer monsoon, when the soils are easily plowed, and enough moisture is retained to permit growth until the winter rains yield new supply. Deficient rain in summer or an early retreat of the summer monsoon is followed by a heavy decline in wheat acreage with a consequent shortage of yield scarcely enough to meet consumption; on the other hand, when conditions are favorable, the export rises to 10 million bushels.

Harvest comes in early spring before the great summer heat, and only in the colder sections of the northwestern provinces does the harvest season extend as late as May. On the hilly uplands south of the Ganges Plain, where in many places the soils are infertile and irrigation facilities restricted, wheat declines in importance and barley replaces it as a winter grain.

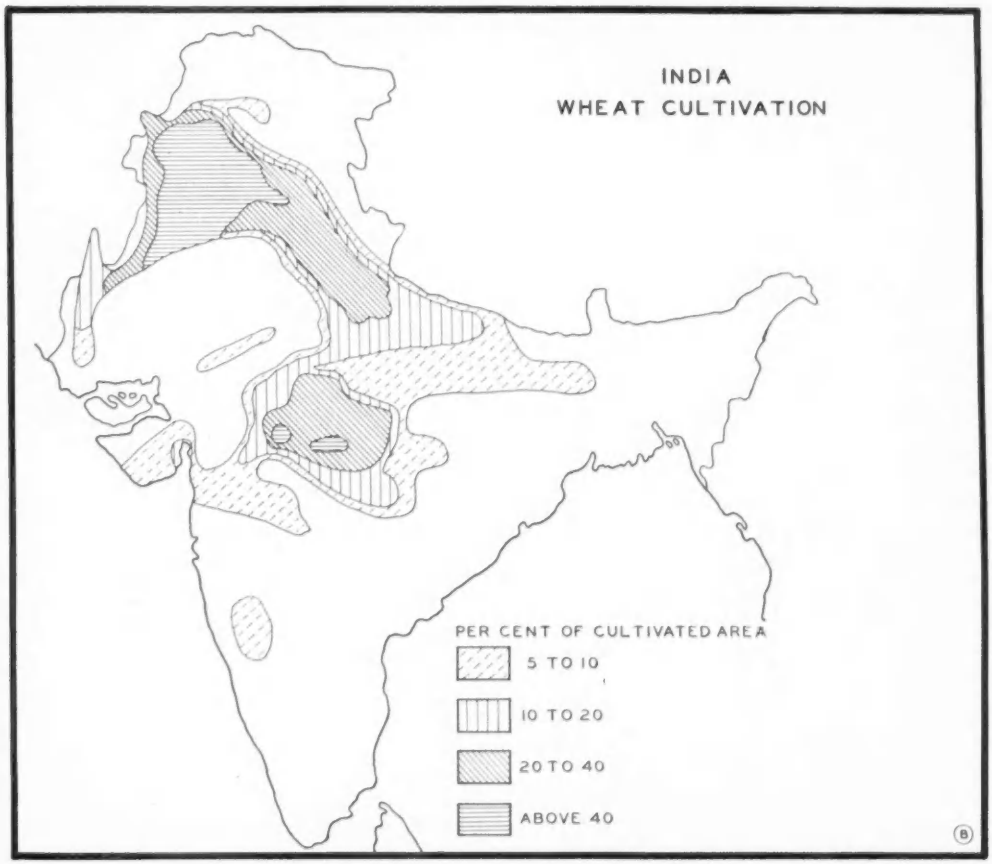

FIGURE 10.—The wheat acreage of India is concentrated toward the northwest where the quantity and character of rainfall are more favorable to its growth. It occupies 30 million acres, and ranks third in importance, being outranked by rice and millet. Except where the crop is irrigated, the yield of wheat is conditioned upon the rainfall.

The black cotton soils of the northern Deccan comprise a second area of important wheat production. Here winter rains play a minor part in the conditions, for the soil retains enough moisture from the rainy season to fill the grain and ripen the wheat fully. Here, too, wheat is in many places the only grain crop, because the black soils are generally too wet during the summer to be cultivated for kharif crops. The southern limit of the wheat region is set by the October isotherm of 79° F. as Engelbrecht so definitely pointed out, for south of that line wheat production almost ceases except in scattered areas.

On the higher lands of the Deccan, wheat production extends southwards to the Mysore Uplands, its southernmost extension. Another small, but locally important, area of production, lies about the Gulf of Cambay, where jowar and wheat compete for dominance in land occupancy.

Barley

Barley, which ranks second to wheat in importance as a winter or rabi crop, grows under similar climatic conditions, except that its limitations are not so rigorously set and its area of distribution extends beyond the limits of wheat production. It occupies 7 to 8 million acres, 25 per cent as large an area as wheat. Because wheat is more valuable, both as a food and on the market, barley is crowded out upon the less fertile soils, or on the more inadequately watered soils, either because of deficient winter rain or insufficient fall rain. Most of the barley is grown on the plains of the United Provinces (see Fig. 9), where winter rains are not so copious as along the foot of the Himalayas and on the Punjab side of the Indian Desert where lack of moisture in autumn prevents the germination of wheat except under irrigation. The small oasis of barley on the Nilgiri Hills depends upon the cooler temperatures consequent upon higher elevation. Barley is sown in fall and harvested in early spring before the wheat. In the dry climate of the Upper Indus (the Leh Region) where the winters are severe, barley becomes a spring crop harvested in later summer and ceases to be a winter crop.

Other Winter Crops

Chickpeas, in many places mixed with wheat and barley in the fields, are grown to a considerable extent in the Punjab and the United Provinces, on the black soils of central India and the higher western part of the southern Deccan Plateau.

Flax, grown upon 3 million acres, furnishes linseed oil and not fiber.

Rape and mustard, also grown upon 3 million acres, augment the sources of oil production.

Tobacco, which occupies 1¼ million acres, is generally grown only to meet local needs, but it has become of commercial significance at the foot of the Himalaya Mountains between the Ganges and the Brahmaputra Rivers, where well irrigation, carefully applied during the months of its growth, produces an inferior crop of considerable importance. It is sowed in late summer, transplanted a month later, and harvested in late winter or early spring. It is of coarse texture, but efforts are being made to provide a variety to satisfy the demands of a rapidly increasing cigarette consumption.

(NOTE.—*The second part of the agriculture of India, the treatment of the several regions in detail, will appear in a later issue.*)

THE COAST PLAINS OF SOUTH INDIA

PART II

Ethel Simkins

COMMERCIAL CROPS

UNDER this heading are included cotton, oilseeds, wheat, tea, and coffee. Of these, oilseeds and wheat are native food crops as well as export crops. This is significant, for the chief barrier to extensive commercial cropping throughout India is pressure on the crop land for feeding the 318 millions of people. With the India ryot there is no question of any competition with the crops which feed him and his family. Thus it is, that in comparison with food crops, the acreage under commercial crops in India is low (Fig. 20, Part I). Particularly is this true of the coast plains which, though regions of good productive power, are also regions of dense population. Even with their present low acreage under commercial crops the emigration from them is great.

The only commercial areas on the plains are those which have facilities allowing of commercial cropping without danger to food crops. The first of these is in the rich tracts of Surat and Broach where the regur soils and good rainfall allow of a margin being available for commercial cropping. A similar state of affairs is found on the regur soils in the south of Madras, where cotton is grown for export, but it will be observed that here, owing to the decreased fertility of the soils as compared with Broach and Surat and the decreased rainfall, cotton is the only commercial crop, while in Surat and Broach both wheat and cotton are grown for export. Cambodia cotton and groundnut, which are other commercial crops of the plains, are a more intensive than an extensive form of cultivation. Cambodia cotton is grown almost always on garden land irrigated from wells. Both are money crops, and groundnut is also a native food which is a big factor in favour of its cultivation. The area in both cases is restricted in spite of its profitability.

The coffee, tea, cinchona district is one of commercial cultivation in its strictest sense, since rice and perhaps a little millet is grown only in sufficient quantities to support the labourers on the estates. The prosperity of these regions is bound up in their commercial crops, which do not come into conflict with food crops, for these hill areas have little or no population. Even the labourers for the plantations have to be recruited from the rice plains on either side of the hills. Thus commercial cropping can be extended indefinitely here, so long as sufficient food can be found for the labourers. Many of them have their own rice land on the plains which they cultivate between the seasons when their labour is not required on the plantations. This, however, is not by any means a universal characteristic among the plantation coolies, and some food must be grown in the area.

On the plains it is clearly seen that it is the southeastern area which is most developed commercially. The explanation lies in several factors. Firstly, it is in the southeast region

that the regur plains suitable for cotton cultivation are found. Secondly, the Agricultural Departments in this area of Madras have been very active in fostering the growth of commercial crops so long as they do not interfere with the food crops, and have given the ryots great help in this direction. Thirdly, the inhabitants of this part of India are the Tamils, notoriously a thrifty, hard-working, and enterprising section of the Dravidian population, and much in advance of their Telugu brethren to the north. These Tamils have shown their enterprise by emigrating as far from India as East Africa, and form the bulk of the coolies who go to Malay and Ceylon. The native population is undoubtedly a big factor to consider in discussing the possibilities of commercial crops, for in some parts, as in Hyderabad, the natives are conservative and slow to adopt either new methods of cultivation or new crops. It is in a large measure due to the virile Maratha population that the northwest Deccan is so advanced in commercial cropping, and the Tamils of South India occupy the same position in relation to the population of the plains as the Marathas do to the population of the plateau.

FIGURE 40.—With the exception of the small area of Cambodia or introduced American cotton in southern Coimbatore, the distribution of cotton coincides with that of regur soils and low rainfall regions of the plains. The best cotton is the Cambodia, but the native cottons of the plains which are far more extensively grown are some of the best in India.

COTTON

India is the second largest producer of cotton in the world and of this 76 per cent in 1927–1928 was produced on the Deccan and the plains around it. All the crop is short stapled and of use only for coarse cloths, but the introduced American varieties have a slight advantage over the native ones. More scientific cropping might improve the quality of the crop but to the ryot cotton cropping is only secondary to food cropping, and the general rural poverty combined with the conservative attitude of the population make the task of the Agricultural Departments in introducing better methods very difficult.

The native cottons are naturally short stapled and the short growing season in India, which is only from three and one-half to four months, militates against any great improvement in them. The American varieties owe their longer staple partly to their inherent nature and partly to the fact that they are grown under irrigation and thus have a longer season. Both types are grown on the plains.

The most northerly belt of cotton cultivation on the plains and one of the best cotton districts of India is the western continuation of the pla-

teau cotton belt, which extends westwards from the Central Provinces to the coast along the Narbada and Tapti rivers to the alluvial black soil plains of Surat and Broach. Here on the west coast the rainfall is higher than in Khandesh being 40.68 inches at Broach and 41.12 inches at Surat as against 22.7 inches at Shirpur (W. Khandesh), 27.32 inches at Bhusaval (E. Khandesh), and 32.26 inches in Amraoti. Thus from the rainfall alone it might be expected that the districts of Broach and Surat would produce a longer stapled cotton than the districts immediately to the east of them. This advantage is enhanced by the fact that the deep black soils are almost at their richest in these alluvial plains and so retentive are they that, though the rainy season here lasts but four and one-half months, they can support a cotton crop which takes eight months to mature. As a result Broach and Surat produce one of the longest stapled and best varieties of the indigenous Indian cottons.

FIGURE 41.—Indian woman manuring cotton seed. Manure is expensive in the cotton districts for the black cotton soils are treeless and dung is the only fuel obtainable. Fortunately regur has a natural restorative action in that the soil cracks deeply in hot weather and the top soil is continually blown or washed by the first rains into the cracks so that the bottom layers of soil are brought slowly to the surface. Regur can be cropped continuously and suffer little depletion. (Courtesy of Indian State Railways.)

South of Broach and Surat along the west coast the cropping of cotton ceases abruptly owing to the heavy rains and light soils, and it is on the east side of the plains, in the Madras Presidency, that the other cotton-growing areas are found.

The cotton areas of Madras may be divided into three groups. Firstly, the Deccan area where conditions have already been discussed. Secondly, the tract in the black soil districts of Guntur, Kistna, Godaveri, and Nellore, where the cotton is termed *Cocanadas*. Thirdly, the southern district comprising Coimbatore, Salem, South Arcot, Trichinopoly, Madura, Tinnevelly, and Tanjore, which is the most valuable cotton district of India.

The Cocanadas tract in the northeast follows the black soil belt in the Kistna and Godaveri deltas. Here the crop is grown with the southwest monsoon and not with the northeast monsoon as in the south. The cotton, though of good fibre, is only of very short staple (5/8 inch to 7/8 inch) and is not important commercially.

South of this belt no cotton is grown on the eastern plains because of light soils and heavy rainfall until the southern area of Madras is reached. Here conditions are very similar to those of the great cotton lands of the Deccan—regur or black cotton soil, and a low rainfall. At the outset, however, a distinction must be set in these regions between the indigenous Indian cottons of which the chief varieties are *Uppam*, *Nadam*, and *Karunganni*, and the

introduced American varieties which are known as *Bourbon* and *Cambodia*. The latter is the most important and is known in the cotton market as *Tinnevelly American*. The distinction between the varieties is made on the grounds of their requirements for growth. So different are they that the introduction of American cottons into this area has not affected or displaced in the least the area under the indigenous cottons. The latter are grown on the heavy regur soils while the former will only thrive on the lighter red loams.

The indigenous Indian cottons are suited to regur soils since they have very long roots which feed and draw their water from well beneath the surface. This makes them able to continue growing undisturbed by long drought, and heavy showers, with long breaks in between, do not damage them. Of all the indigenous cottons of India the type known as *Karunganni* is reckoned to be the finest, and much of the crop finds its way to the Lancashire market where it passes under the trade name of *Tinnevellies*. It is a good strong fibre with a staple of seven-eighths inch to one inch and is practically the only Indian cotton which is considered good enough to mix in with American. Much is being done by the Agricultural Departments in these districts to improve this type of cotton.

The American cottons are cultivated under very different methods from the indigenous varieties. The latter are "dry" crops on black soils, the former are irrigated or "wet" crops on red soils. American cottons are essentially shallow-rooted or surface-feeding plants, and are useless in heavy soils like regur, or in an irregular climate like India, for during breaks in the rains when the surface soil becomes baked hard they wither and die.

FIGURE 42.—A field of cotton. (Courtesy of Indian State Railways.)

In spite of the fact that these southern areas, where American cotton is grown (principally Coimbatore), get the benefit of the monsoons, and have a better-distributed rainfall than any other part of the Presidency, the bulk of the American

cotton is grown under irrigation, so abolishing any possibility of breaks in the rains damaging the crop. A further point of importance about these American cottons is that being surface feeders, they are very exhausting to the soil; they require good rotations and heavy manuring, the latter being supplied a good deal by cotton seed. Thus, the crop is an expensive one to grow.

It will be seen on the irrigation maps (Figs. 13 and 14, Part 1) that in areas where Cambodia cotton is grown, well irrigation is predominant. It is grown in rich and heavily manured red soils under well irrigation—a typical "garden" crop. It is often followed by an after crop of tobacco or vegetables and sometimes by a dry crop of ragi or pulse. The latter crop, being leguminous, is a very valuable item in the rotation as a restorative. Cambodia cotton is the most valuable of all Indian cottons for it has a staple from one inch to one and one-sixteenth inches with a uniform fine, glossy, strong fibre. Furthermore while the indigenous cottons will only yield 90 to 100 pounds per acre, Cambodia will yield 500 pounds. Thus, wherever a cultivator possesses good garden land, Cambodia is a paying crop, or as the cultivator terms it—"A money crop," and it has replaced tobacco and chillies as the principal crop on many garden lands.

The chief area of the South for the cultivation of Cambodia is in Coimbatore district, on the red soils at the foot of the Palni hills, the districts of Polachi and Palni being the principal, but it is being extended to many parts of these southern districts, wherever the requisite garden land is available, on account of its profitability.

FIGURE 43.—Harrowing cotton with a tractor. This shows the introduction of modern methods on a Government farm. Elsewhere only primitive native implements are in use and are likely to remain so, owing to the poverty and conservatism of the ryot. (Courtesy of Indian State Railways.)

Though the American varieties of cotton in India are undoubtedly superior to the indigenous varieties, they can never be introduced on such a large scale as to replace the latter for this is physically impossible. The chief cotton areas of India are regur lands on which American cotton will not grow. Secondly, whenever the American cotton can be grown, it must be mainly irrigated owing to the erratic rainfall, and in South India, because of the dense population, the irrigated land must always be mainly given over to rice. Thus it seems highly improbable that the American varieties—Punjab American, Dharwar American, and Cambodia—will ever approach in quantity to the Indian varieties, though they are, and still will be, the most valuable in quality. The improvement of the indigenous cottons is therefore the greatest work before the cotton experiment stations, not only in the interests of the English cotton industry, but in those of the Indian cotton manufacturing industry, which, as it expands, will require

longer stapled cottons for its finer counts.

WHEAT

Only one part of the coast plains is physically suited to the growth of wheat—the black soil region of Surat and Broach, which is a continuation of the wheat belt of the Deccan.

Wheat, although a temperate crop, can be grown in India in the cool season. It is sown in this cool season and reaped at the beginning of the hot season provided there is the necessary water, for in most of India the cool season is the dry season. This water, in the Punjab (which is the chief wheat area of India) is provided by irrigation, but the deep regur soils of Surat and Broach are able to conserve sufficient water from the heavy rains of the summer or "Kharif" season to bring the winter or "Rabi" crop to maturity. South of these regions wheat is absent from the coast plains owing to the heavy rainfall. The only area where it might be grown is the dry southeastern area of Madras where the regur soils are found, but here temperature conditions militate against it, for the rabi or cool season is too short to allow of the wheat maturing before the intense heat sets in. These areas are similar to those of the Madras Deccan in this respect.

FIGURE 44.—A cotton market. (Courtesy of Indian State Railways.)

OILSEEDS

Oilseeds are becoming one of the leading factors in India's agricultural production for not only are they essential and widely-used food crops, but also one of the chief export crops. "In spite of the fact that India is the

world's greatest exporter of oilseeds more than half the groundnut crop, three-quarters of the rape and mustard, and three-quarters of the cotton seed are retained in India, and there are many minor oilseeds which are practically wholly used for home consumption. Thus it is that the importance of oilseeds in India is rapidly increasing." [1]

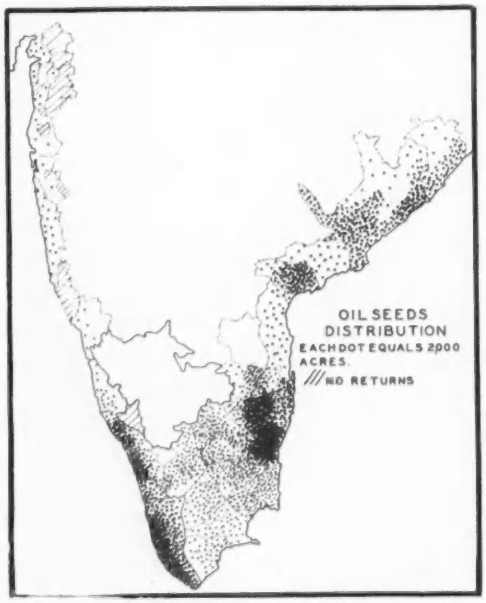

FIGURE 45.—Distribution of oilseeds. These include groundnut, coconut, sesamum, rape, mustard, and castor. Oilseeds are one of India's chief products both for home consumption and for export. It is significant that every area has some oilseed, for where one will not grow, another takes its place. An example of this is in the southwest where coconut thrives under conditions which are unsuited to other oilseeds. Note the areas of commercial production of groundnut in eastern Madras.

Many varieties are grown, the chief being linseed, groundnut, sesamum, castor, niger, safflower, rape, mustard, and coconut, but three of the chief varieties may be taken as typical.

Groundnut is one of the main commercial oilseeds of South India, and one which has shown more rapid expansion in the last twenty years than any other. It is a favourite food crop with the natives, but it is valued commercially for its high percentage of oil which in some varieties is nearly 48 per cent. The introduction of the commercial aspect of its cropping has made great changes in the old native production, since introduced varieties, particularly the Mauritius type, are infinitely superior to the native ones and are superseding them in most areas. They have a higher percentage of oil and they take only three and one-half to four and one-half months to mature, as against six months for the native crop, so rendering them less liable to be attacked by the fungoid "tikka" disease, which ruins many of the native crops.

Groundnut will grow within a wide rainfall range, provided the soils are suitable. Unirrigated, it can be grown under rainfall conditions from 40 inches to 70 inches and below that it can be grown irrigated. It is, however, limited in its growth by soil conditions, for it requires a rich, but light and friable, soil owing to the peculiar growth of the plant.

Even under suitable physical conditions however, its growth is limited by two factors, the first of these being expense. Heavy manuring and irrigation cannot be carried out unless there is some capital outlay; hence, in its early stages of commercial cropping, groundnut was grown only by the richer cultivator who rotated it on garden land with such crops as chillies or tobacco. It was found that the profit on such lands was so great (Rs 32 per acre) that it amply repaid any outlay, and in Southeast Madras, the chief sphere

[1] Indian Trade Enquiry "Report on Oilseeds." —Imperial Institute.

of its cultivation, it has extended to all the rich loamy lands in the region, both in the valleys and on the lower hill slopes, and is grown either as a dry crop, or under irrigation from tanks or wells. It has replaced such crops as tobacco and chillies on garden land, and has become the predominant crop of the region.

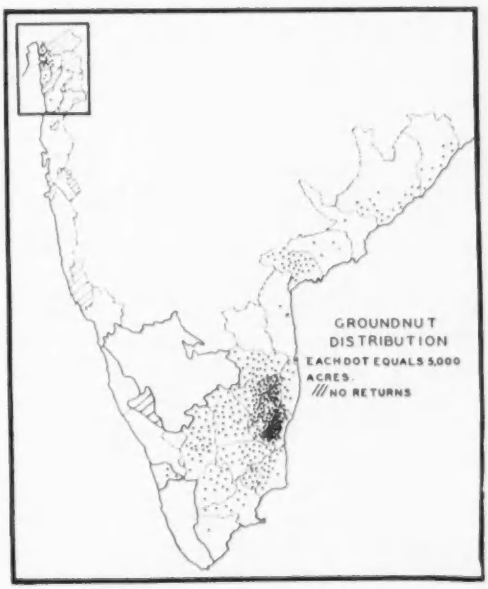

FIGURE 46.—This is one of the most profitable oilseeds of South India, both for home consumption and export. Note the concentration in North and South Arcot areas (S. Madras) where the Agricultural Departments are fostering the industry and conditions are very suitable. Wheat is a crop of the regur soil and low rainfall regions of the northwest plains only, for the rest of the coast is either too wet or too hot for it. This region of Broach and Surat is really an extension to the coast of the Deccan wheat region owing to the absence of the Ghat barrier.

Much of the expense entailed in cultivation is due to a second limiting factor in its growth—labour. Throughout growth the plant requires much care, but the biggest demands come at harvesting when the nuts are picked. Normally about fifteen diggers and seventy-five pickers are required per acre. It is not so much this which raises the labour difficulty, but the fact that should a fall of rain occur after ripening, the nuts sprout and the crop is spoilt. The aim of every farmer is to garner his crop with the greatest possible speed and diminish the risks. When the cultivation of the crop is small, he has little difficulty in doing so, but when, as in the districts studied, hundreds of acres are cultivated in each small district, the competition for labour is keen, and wages are forced up with the final result that out of a total cost per acre of Rs 80 for growing the crop, labour costs at least Rs 30. Thus it comes about that "Scarcity of labour is one of the serious drawbacks to the present system of groundnut cultivation, and will always be so, especially in the dry red soil tracts which will not support a large population."[2]

Cultivation shows decided localisation on the plains, partly on physical grounds, and also partly because in the southeast areas of Madras, the Agricultural Departments have fostered the growth of groundnuts as the great commercial crop by introducing superior varieties, and instructing the ryots how to grow them to the best advantage. This groundnut area of Madras extends throughout the lighter loamy, well-drained land in Chittoor, North Arcot, South Arcot, Tanjore, Trichinopoly, Coimbatore, Salem, Madura, and Ramnad, but it reaches its greatest intensity in North and South Arcot, where on lands varying from rich valley loams to quite poor red soils on the slopes, groundnut is grown with profit. It is the only commercial crop of importance in these areas, and is rapidly supplanting tobacco and indigo.

On the west coast the cropping of groundnut is absent owing to the

[2] Sampson. *Groundnuts in Madras*, 1889.

heavy rainfall. Indeed, few oilseeds will thrive under the conditions on this coast, for they are crops of moderate rainfall regions. This is evidenced by the distribution of til or sesamum which is one of the most widely used oilseed crops in India. It will grow on much lighter and poorer soils than groundnut, but in spite of its hardy nature, it cannot stand the heavy rainfall of the west coast and so shows scanty cropping.

Til shows extensive cropping in the southeast area in the same zone as groundnut cultivation, but it does not occupy the same land as groundnut, usually being a dry crop on the lighter soils, though it is grown as a second crop after rice on irrigated lands. It is chiefly important as a native food crop, but, as in the case of groundnut large quantities are exported. It shows extensive cropping in the northern areas of Madras as well as the southeast, being grown throughout the delta lands and in the light soil regions of Vizagapatam and Ganjam where groundnut will not grow.

Coconut is the great oilseed of the coast regions where none of the previously mentioned seeds will grow because of the heavy rainfall. It thrives under heavy rainfall and high temperature conditions. It will be noticed that it shows by far its densest cropping in the southwestern areas, in the Kanaras, Malabar, Cochin, and Travancore. This is due to the high rainfall and temperature conditions. A map of its distribution, having for example one dot for every 10 acres under the tree, would show that it is grown as far north as the northern part of Thana, but in these northern parts it is unimportant as compared with the hot wet districts of the southwest where

FIGURE 47.—Coconut is the oilseed of the hot wet southwestern district of the plains. Here it is one of the necessities of life providing food, drink, oil, and fibre for the natives and a valuable export in copra.

it is practically one of the necessities of life.

Here are ideal conditions for coconut cultivation, a constantly high temperature, and a rainfall of 70 inches and over, and very suitable soil conditions. Coconut is not a tree that will thrive on heavy clay lands. It requires a fine permeable soil but a very rich one owing to the particular root system of the tree. It has no tap root but a vast number of roots which spread out laterally in all directions, some within a foot or two of the surface and which can only thrive in a soil which can be penetrated easily. The ideal soils for coconut have been found to be either alluvial loams on river banks which have plenty of water from streams, or the sandy loams which border the sea coast.

Thus the cultivation in the West is dense, especially on the sandy

alluvium and the banks of the lagoons fringing the coast. So important is it in these districts that whole castes have as their livelihood the tapping of the trees for toddy, or the cutting down and hulling of the coconuts. A full survey of the uses of the coconut in this region would be irrelevant here where the interest is only the oil which is extracted from the interior white portion of the nut. This is either used at home or dried and sent abroad as "copra." The oil is of very good quality and that from India is considered one of the best types in the world, the copra yielding from 65 to 67 per cent of oil, sometimes even 70 per cent.

It will be a great advantage for all the oilseed districts when capital can be found to introduce modern crushing mills. This will be an advantage in three ways: firstly, it will provide a profitable industry in India; secondly, the modern scientific machinery can obtain a higher percentage of oil from the seed than the crude native crushing mills; and lastly, but by no means the least in importance, it will allow of the waste after crushing, either being returned to the land as manure, or being given to the cattle as food. This will supply two great deficiencies at the root of much of the backwardness of Indian agriculture—fertiliser and fodder.

COFFEE AND TEA

Coffee and tea are very similar in their requirements, hence their distribution in South India is almost coincident as shown in Figures 48 and 49. Further, these crops are confined to very limited areas, owing to their particular requirements. Coffee requires a rich, though not too heavy, loam (not necessarily deep since coffee is a shallow-rooted plant and draws its nourishment from the upper layers of the soil). This loam is usually red or lateritic and rich since all the coffee plantations are but cleared areas of forest land enriched by the humus of hundreds of years. Hull in his "Coffee Planting in South India" says that "the best criterion as to the quality of the soil is the luxuriousness or otherwise of the vegetation it produces in its original state."

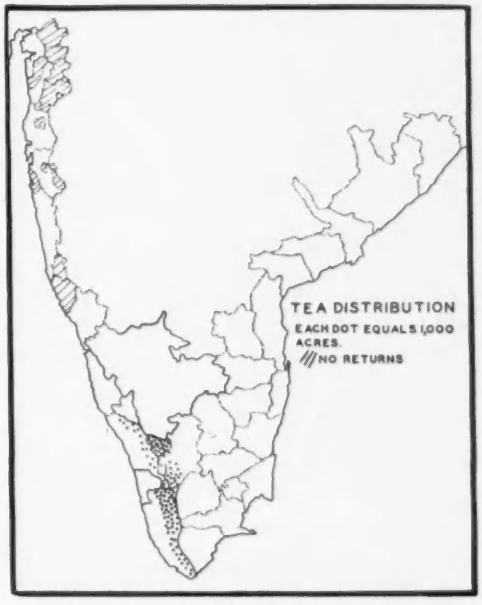

FIGURE 48.—Distribution of tea. One dot equals 1,000 acres.

Coffee is found at altitudes from as low as 400 feet (though this is not usual) to nearly 4,000 feet, but everywhere on a sloping surface since good drainage is very essential. Surface erosion on these slopes is prevented partly by the presence of shade trees, and partly by the humus covering which keeps the soil in place. Other precautions are used but in spite of them, many parts of the coffee and tea country have become deserted

owing to heavy surface scouring by the rains.

The required conditions are found in the plantations in Southern India along the Western Ghats in Mysore and Coorg, and in the hill groups to

FIGURE 49.—The distribution of coffee and tea are practically coincident, both occurring on the rich humus soils with heavy rainfall on the hill groups of South India. This is the only region of South India where large-scale production under white proprietorship is practised. (For the northern extension of the coffee-tea belt in Mysore, see Deccan study by the author.)

the south of the plateau in Madras and Travancore, the principal groups being the Palni, Shevaroy, and Cardamom hills. The fact that these regions are all in the extreme south proves that there must be a further limiting factor besides soil and drainage, this being the rainfall. Over 70 inches falls on these mountain slopes, but the limiting factor in the growth northward is the amount of spring rains, which decreases northward. Coffee flowers in Spring, and on the flowering depends the fruiting. Successful flowering is dependent on these spring rains, or, as they are called on the plantations, "blossom showers." If these fail, the blossom shrivels and the fruit is poor, hence a spring rainfall of five to six inches is the limiting factor in its growth northward. Coffee can be grown no further north than Shimoga in Mysore because of deficiency of spring rains to the north of that State, but there is no rainfall limit to its growth southwards. It extends to the southern tip of the Cardamom hills, and the tea and coffee areas of Ceylon may be taken as an extension of the same region since they are similar in all respects to it.

Much of the tea area in South India was originally under coffee, but the importance of coffee here received a severe setback, partly from the ravages of the coffee borer, and partly from the competition of cheap Brazilian coffee. Tea, it was found, could be grown very successfully on land which had been originally under coffee, and it was not attacked by blight. Moreover, it did not have to face such competition in the world market as coffee, since Indian tea was becoming more popular to the European taste than Chinese tea. Hence, much of the land in the Nilgiris Wynaad and Travancore is now very successful tea land. Tea, like coffee, can be grown to altitudes of 6,000 feet, but the greater part is at an elevation of about 3,000 feet. The altitude affects the quality of the tea considerably. Although a higher yield can be obtained at lower altitudes, the teas grown on higher slopes because of less tropical conditions are usually of a better quality and flavour, and the price they command is higher than that for the lower teas.

Another tree grown in this region is the *cinchona* from which quinine is

FIGURE 50.—A squad planting tea. The tea and coffee plantations are the only agricultural undertakings in South India with white ownership and coolie labour. (Courtesy of Indian State Railways.)

derived, and which has very similar requirements to tea and coffee.

PRODUCTION REGIONS OF THE COAST PLAINS

The term "production region" in this study is applied to areas where a particular group of crops grow together in association, either because they require similar conditions for growth or because they are supplementary to one another.

In the Deccan study the basal division of the production regions was made on those with jowar as their principal crop and those with rice as their principal. On the plains no such basal division can be made, for rice is either the dominant crop or one of the dominant crops in every association but one. This latter is in Surat and Broach and is rather a coastal extension of Deccan conditions than a plain land type. The transition from the jowar zone of the plateau to the rice zone of the plains is well shown in the Western Bombay Presidency.

At the Eastern foot of the Ghats in the flat heavy soil country is the realm of the jowar millet and its associated groups. As the better soils are left behind on ascending the rugged slopes of the Ghats, bajri and other light soil crops replace jowar. Still higher as the rising rainfall compensates for the lighter soil, the rice domain, which is characteristic of all the country west of this to the sea, is entered. Precisely the same transition is observed in passing to the east of the jowar zone. The red soils replace the regur soils, and the rising rainfall permits of rice growing mainly under irrigation. The transition on the east side is, however, more complex and prolonged than on the west side where it is rapid and clearly defined owing to the height of the Ghats and their effect on the rainfall.

Hence, since in South India the

rainfall rises as it approaches the coasts from the centre, rice cultivation also increases towards the coasts from the centre, so that the jowar zone is almost encircled, firstly by an

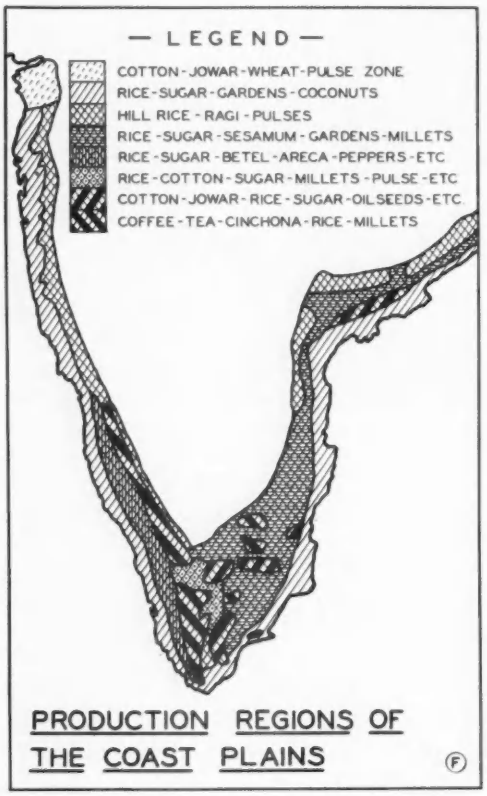
— LEGEND —
COTTON - JOWAR - WHEAT - PULSE ZONE
RICE - SUGAR - GARDENS - COCONUTS
HILL RICE - RAGI - PULSES
RICE - SUGAR - SESAMUM - GARDENS - MILLETS
RICE - SUGAR - BETEL - ARECA - PEPPERS - ETC
RICE - COTTON - SUGAR - MILLETS - PULSE - ETC
COTTON - JOWAR - RICE - SUGAR - OILSEEDS - ETC
COFFEE - TEA - CINCHONA - RICE - MILLETS
PRODUCTION REGIONS OF THE COAST PLAINS
F

FIGURE 51.—The distribution of the various important crops of the coastal regions of India may be expressed in approximately defined regions which help to relate the agriculture and land utilization to the climate and other physical factors as well as to the distribution of the population.

intermediate zone between jowar and rice, where rice is grown in the valleys and millets on the slopes, and finally by the true rice zone of the plains where no other crop approaches rice in importance.

This overwhelming dominance of rice cropping has its effect on the rural economy throughout the region. In spite of the fact that these plains were the first to be affected by Western influences (being on the coast), they are still almost exclusively areas of native food production. A typical village of the rice country, Eruvellivet, situated 100 miles south of Madras, has been described by Slater in his "Some South Indian Villages" and it may be taken as typical of all the rice villages of the plains with minor exceptions. It is a small village as are most of them in this overcrowded region, its area being 1,139 acres. Of this number, 722 acres are cultivated and the rest is waste for cattle or for collecting fuel. Of the cultivated land 542 acres are wet land and 180 acres are dry land, the former being assessed for land tax at Rs 4.15.6. and the latter at Rs 1.6.0. The average holding in the villages throughout India is small and formed of bits scattered all over the villages. Slater gives figures of one holding of 29.7 acres, which is in twenty-one parts.

There has been a tendency in recent years in the rice zone, particularly that of Madras, for the wealthier ryots to accumulate larger holdings which have been sold by the poorer ones in payment of debt. This has resulted in a big increase of emigration to the Cingalese plantations. Thus, in spite of the intense cultivation the population of these rice lands is so great that the only solvent of the problem of how to make the land support the people is emigration. This may be either temporary or permanent to the factories of such towns as Madras, Madura, Trichinopoly, or Bombay, or to the plantations of Ceylon, Burma, Malaya, or the Nilgiris, and it is a regular part of the life of these villages. According to the 1921 Census, Madras lost one and a half millions of

her population through emigration and the figures are probably in excess of this now.

When the emigration is temporary, the village benefits considerably with the return of the labourers. The labourers on the South Indian plantations usually stay about ten months and save Rs 35.47.

In Bombay it is reckoned that the number of temporary immigrants into the city during the off season in agriculture (the hot season) is 125,000 out of 590,000 not born in the city. Thus, commercialisation, though it has not shown its effect by substituting commercial for food crops, has made itself felt in drawing off the village labour either permanently or temporarily to commercial undertakings.

The village cropping figures show that of the total of 722 acres cultivated, 499 acres were under rice, the rest being used for garden crops like sugar cane, oilseeds, some vegetables, and ragi on the poor land. Cultivation was poor for there was only one team of cattle for five and one-half acres of land and there should be, for good cultivation, at least one pair of bullocks for every four acres. Here again Eruvellipet is typical of the rice villages with their shortage of, and bad condition of, the animals. This is due partly to the poor plain breeds, and partly to the fact that rice straw, which is the only fodder available in the region, is a very poor one and the cattle are underfed (See Fig. 31, Part 1).

The village is practically self sufficing. Slater gives the following description of it: "To a great extent the village is self supporting. The various sets of habitations in the caste village and the parish village are made almost entirely out of local materials. Bricks and tiles are made. There are carpenters and blacksmiths, goldsmiths, schoolmasters and priests, a post office in charge of the headmaster of the school. There are two oilmills besides the sugar mill worked by an oil engine. Agricultural implements and carts are made by the village carpenters of local timber. There is no weaving done in the village, but there is a weaving village a few miles away. Palmyra trees supply toddy and jaggery. Religious festivals supply the more imperative spiritual cravings. . . . There is a village fund to promote the economic wellbeing of the village."

Such a description serves to bring out this remarkable fact about the rural economy of this rice village. In spite of the fact that it has been brought into close contact with the West and all that it means in India (the village is only 100 miles south of Madras), the natural conditions have been too powerful to allow the economy to be affected by these external influences. The village, in spite of railways, commercial cropping, and industry, bases its whole economy on the growth of its food crops, and the only way in which it has reacted at all to Western influences is in the fact previously mentioned of the emigration of its surplus population to areas of deficient labour. In this, it is typical of the coastal rice regions. They must always be food producing for their great population irrespective of commercial requirements.

PRODUCTION REGION 1

Rice, Sugar Cane, Garden Cultivation, Millets, Pulses, Coconuts

This is the most widely distributed of all the production associations of

the plains, and is found on the lowest and richest lands bordering the coast on both the east and west sides, which have either heavy rainfall as the west, or good irrigation facilities as the east. Rice is grown on the heavy rich loams throughout the region, at least one crop, and sometimes more, being grown according to the length of the rainy season and the amount of rain. Pulse is often grown as a second crop after rice, and sugar cane is found on similar soils to rice and is usually grown in rotation with it. Its importance, however, cannot be compared with that of rice in this association, since in Madras as typical in 1919–1920 only eight-tenths of one per cent of the irrigated area was under sugar while 85 per cent was under rice. The garden cultivation is found on the lighter but rich soils which are used for spices, ginger, or vegetables, which always find a ready market. This type of cultivation is scattered throughout the plain country particularly near big cities like Bombay and Madras, where its products are much in demand. Like sugar cane cultivation, however, it is only a poor second to rice. The coconut, which is also characteristic of this association, is the element in it which supplies the oil necessities, for as before noticed, every part of South India has some oil crop. Its densest cultivation is in the southwest, from the Kanaras south to Travancore where the rainfall and temperature are extremely high and it approaches in importance here to rice, as one of the subsistence crops of the people. This is about the only part of this rice association where another crop assumes great importance. In the northern part of the zone both on the east and west coasts the coconut decreases in importance owing to temperature conditions, but it is still grown on the lands fringing the coast. Its cultivation is limited on the east coast, even in the south, owing to the decreased rainfall.

FIGURE 52.—A native metal worker. The metal craftsmen of India have been famous for centuries, and though factory goods from the West are imported into India in large quantities, she still can boast many castes of skilled metal workers. This is a goldsmith of Delhi. (Courtesy of Indian State Railways.)

PRODUCTION REGION 2

Rice, Sugar Cane, Condiments, Spices, Areca, Betel, Cardamom, Millets, Coconut

This is one of the richest associations of the South of India, it being found in the well-watered valleys of the southwest coast under conditions of high rainfall and high temperature. Here, in Malabar, the Kanaras, Travancore, and Cochin, some of the most luxurious vegetation in all India is found, and, in the rising land between the lower slopes of the Ghats and the plains are scattered the gardens in which flourish such crops as betel pepper and cardamoms, in great profusion. The land is "an endless succession of houses and gardens scattered in picturesque order over the face of the country making it entirely different from the

east coast of Madras."—Gazetteer, Travancore.

Rice and millets are grown in this association as the food crops, the rice usually in the heavier bottom lands of the valleys, and the millets on the poorer dry soils above the gardens. As the rainfall is heavy, ragi is the chief millet. Coconut, which supplies the oil requirements of the region, is heavily cropped in all parts, being one of the staple food and commercial crops.

The villages of this region differ slightly in their economy from the typical rice village previously described, in that spices and coconut both have a commercial importance and rival in importance the growth of rice. Coconut is not only the native food crop, but it also provides copra and coir which are exported via Calicut and Cochin. Further, it supplies many industries, such as net and rope making for the fishing which is carried on along the coast, and mat making and other essentials of village life. In this type of country with the plentiful rainfall, a production not wholly dependent upon irrigation and rice cultivation, and with a native population of Malayalis who are averse to village conditions, the houses are scattered over great areas instead of being congested into villages as is the rule in the rice plains. (The village returns are simply those for a certain administrative area termed the village). This is typical of Malabar, Travancore, and Cochin where the Malayalis are found, and in the 1921 Census an officer remarked that to take the returns for twenty-five to thirty houses on the east coast was comparatively easy, since they were all situated together in one, or, at most, two streets. But in Malabar, to visit twenty to thirty houses probably involved a prolonged tramp through dark and deserted jungle paths.

This is due to the type of production, which is dominantly one of garden cultivation where the cultivator lives amongst his gardens. It is a land teeming with luxurious vegetation owing to its high and unfailing rainfall, yielding an abundance of crops and hence "each house even the humblest stands in its own little compound or garden (thus doing away with the problem of fragmentation), which is planted thickly with areca and coconut palm, jack trees, plantain betel and pepper vines and the like; the whole of Malabar is like a beautiful garden, where live a race of prosperous lotus eaters —each family nestling under its own pepper vine and jack tree" (Gazetteer of Madras). One village may cover as much as about five and one-half square miles or 3,692.64 acres, which is a great contrast to the rice villages of the east coast.

The prosperity of these villages is shown by the fact that the net profit in one of the spice gardens may be as great as Rs 260 per acre. Other profitable occupations in these villages are coir rope making done by the low caste women; fishing, and the tapping of coconut palms for toddy.

Thus, the villages of this production region are more versatile in their economy than the typical rice village. They have a variety both of food and commercial crops and a significant point is that the commercial cropping is a form which does not involve any change in the native economy. It was carried on in the region before the coming of commercialisation, and even now a large part of its produc-

tion is sold in the regions where it is grown.

It is not surprising to find that the emigration from this region is not nearly so great as in the first one cited. The density of population is almost as great as in the Tanjore delta (which may be taken as typical of true plain land rice country), being 415 per square mile as compared with 442 in the latter, yet the emigration figures are far less, and moreover, such emigration as there is goes chiefly to the coffee plantations in the region and is only temporary. It is this region which has gained the name "The Pearl of India" owing to its luxurious vegetation and profitability.

PRODUCTION REGION 3

Hill Rice, Millets, Pulses

Proceeding inland from the rice areas of the west coast up the slopes of the Ghats, though the rainfall is still high, the soils become poor owing to the rugged nature of the land and the presence of laterite. The result is a production region of a poor type with hill rice, ragi millet, and pulses. It is a similar association to that found in the Bombay Deccan since it extends over the Ghat crests and is limited eastward by a rainfall of 50 inches.

The hill rice which is inferior to the rice of the plains is a dry crop owing to the high rainfall and occupies the best soils. Millet is almost as important as rice in this association owing to the preponderance of poor soils. The region stretches from the northern part of the west coast south of the Tapti mouth southward as far as the Kanaras. The same type is found in the mountain country of Ganjam, Vizagapatam, and Godaveri in Madras, and in the Nallamalai Hills of Western Nellore and Kistna.

PRODUCTION REGION 4

Rice, Sugar Cane, Garden Cultivation, Groundnut, Sesamum, and Millets

This association is found in that area of the Madras Presidency which lies between the Eastern Ghats and the low-lying rice zone of the coast south of Nellore. It is more hilly and variable in its topography than the coast plains, owing to the Eastern Ghats and their outlying spurs, but owing to the lowness of the Ghats and the many big rivers which traverse the region, it has great areas of very rich valley soils. Due to the rugged nature of the country, however, the proportion of poor soils is much higher than on the plains bordering the coast. The association is similar to that discussed in the Deccan study for the eastern part of the Mysore plateau.

Rice is the most important crop, it being grown on the valley lands under tank or canal irrigation, and in rotation with sugar cane. Two crops of rice a year are usual owing to the early and late season rains, and often a second crop of ragi or pulse can be grown dry on the rice land if there is sufficient moisture left in the soil. The rice land is in the heaviest soil of the valley bottoms, and on the lower slopes where the soils are lighter, but still rich, are found the groundnut or the garden lands (if irrigated) where chillies, tobacco, and indigo are grown. Groundnut is the chief commercial crop throughout the area and shows its greatest development in North and South Arcot. Sesamum, the second oilseed crop of this area, is grown as a dry crop in much poorer soil than groundnut. The poorest soils of this region are oc-

cupied by hardy crops of millet and pulse. Of the millets both bajri and ragi are grown, the presence of the former being due to the lighter rainfall here as compared with the hill regions of the Western Ghats.

The effect of the introduction of a commercial crop like groundnut into the region has affected the village economy to some extent.

The crop has been so profitable that the ryots are awaking to the fact that the fragmentation of their holdings is a drawback in a region of commercial cropping, and in recent years they have effected exchanges with their neighbours in the effort to get their land in one piece. This is a big step towards agricultural improvement. This region also benefits from the fact that manure is more easily obtained than in the rice plains. Much of the land is hilly and forested, and is used both for cattle pasture and for manure. The result is far reaching. The work cattle are stronger, green manure is available, and the cattle dung instead of being used for fuel, as is the rule in the treeless plains, can be used for manure. A typical village of the North Arcot area had 1,180.53 acres of such common pasture.

All the irrigated land in this village was used for rice and the dry land for oilseeds. The effect of the commercial crop in the association is very evident in the village economy. It was not self sufficing. So much of its land was required for groundnut that it imported much rice from nearby districts and paid for it from the profit of its commercial crop. Moreover, it was far more progressive than the purely rice village. It had set up two rice mills and not only imported to grind in them but passed it on ground to other villages. Such is the progressive effect of commercial ideas in this production region.

PRODUCTION REGION 5

Cotton, Jowar, Rice, Sugar, Millets, Oilseeds

This association with the introduction of cotton and jowar shows a big variation from the average plainland conditions, for it coincides with the distribution of regur soils and low rainfall in South Madras in the districts of Coimbatore, Salem, Trichinopoly, Madura, and Tinnevelly. Cotton and jowar are grown in rotation in these lands, and the lighter red soils are occupied by rice if irrigated and by millets and pulse if dry. Most of the rice is found thriving in the river valleys of which the chief are the Cauveri and the Vaigai. Smaller areas of this association are found in the black soil districts of Ramnad, South Arcot, Nellore, Kistna, Guntur, and Godaveri.

The area under Cambodia cotton is a variation from this production type in that it does not coincide with the regur areas. Cambodia cotton is a garden crop and is grown in conjunction with rice, sugar cane, and general garden crops.

The chief area for this type is at the foot of the Palni Hills in Coimbatore where the soils are rich red loams brought down from the hills and the benefits of both monsoons are received. So profitable is the crop that the association is extending south to the red loam lands of Madura.

These cotton regions are prosperous areas of the rice zone. They have a double food crop basis in rice and jowar, and the latter yields good cattle fodder in addition. Moreover, cotton is one of the most profitable commercial crops in this part of

India, and one which does not conflict with rice for it is grown on different soils. The agricultural departments in these areas are progressive and much benefit is felt from the coöperative movement in distributing cotton seed and marketing the crop. But much improvement still is necessary. Consolidation of the many scattered holdings, selection of seed, and good cultivation are all essential if the best results are to be obtained from the cotton crop.

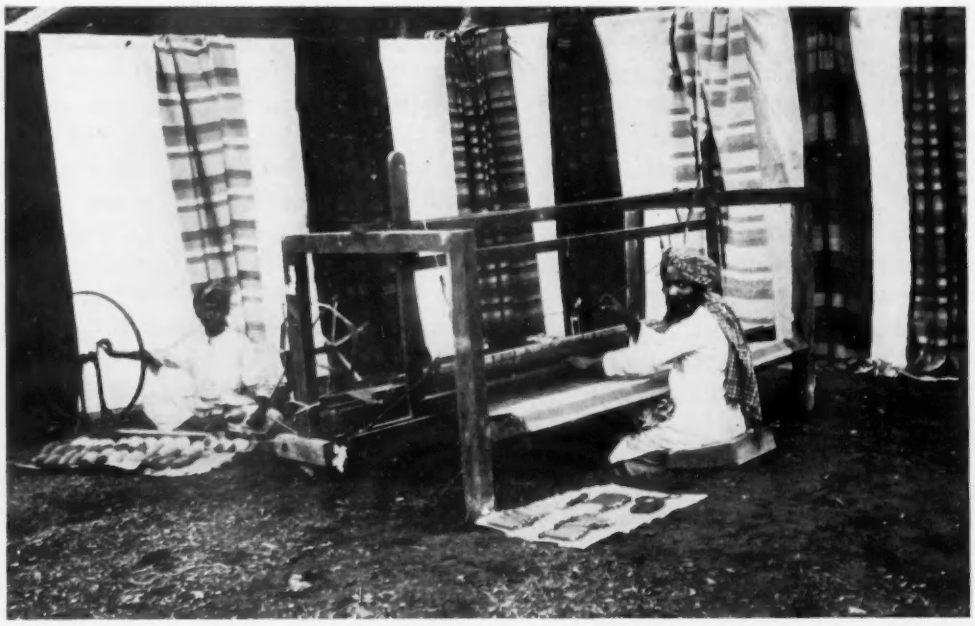

FIGURE 53.—A native weaver. One of the indispensable village craftsmen of India until the introduction of the factory system. (Courtesy of Indian Trade Commissioner.)

Before the advent of factories, the weaving villages of South India were in these cotton areas, and many were paid in paddy or millet for doing the weaving for villages outside the cotton country. With the advent of the factories, however, the old hand loom weaving industries of these areas are disappearing, and instead, in the cotton zone, there are large factory towns like Madura and Trichinopoly (the two largest towns in the Presidency with the exception of Madras), whose cotton mills absorb much of the old hand loom labour of the villages. Figures are not available to show the decrease in handloom weaving in this district, but those for the cotton districts of Kistna may be taken as typical.

	No. of Weavers
1891	69
1901	17
1911	12
1917	3

Until 10 years ago 95 per cent of the villagers wore village cloth; now 75 per cent wear foreign clothing.

Owing to the growth of a commercial crop, these villages, like those in other parts of the rice zone, show a large proportion of emigration not only to the cities but to the plantations outside India previously mentioned.

PRODUCTION REGION 6

Coffee, Tea, Cinchona, Rice, Ragi

This association is found on the slopes of the hills of South India, the chief of which are the Anamalai, Palni, Cardamom, Shevaroy, and Pachmalai groups. All have a heavy and well-distributed rainfall of 70 to 150 inches and rich forest loams soils. The northern limit of this association on these hills is set by the Spring rains on which the coffee flowering depends. Two to three inches in April and five inches in May is the required amount for successful growth.

Owing to the heavier rainfall of the western groups of hills, cultivation is heavier, but the plantations are mainly on the eastern slopes owing to the force of the monsoon which damages the crop and washes away the soil on the western slopes. Further inland the western slopes are the more important since they have the heaviest rainfall and do not get the full force of the monsoon. Hill rice and millets are grown in the region in sufficient quantities to feed the coolies, and in recent years another crop—rubber—has been increasing in importance on the low, wet, forested country at the western foot of the hills. In this zone there is a condition of rural economy wholly different from the typical village economy of the plains.

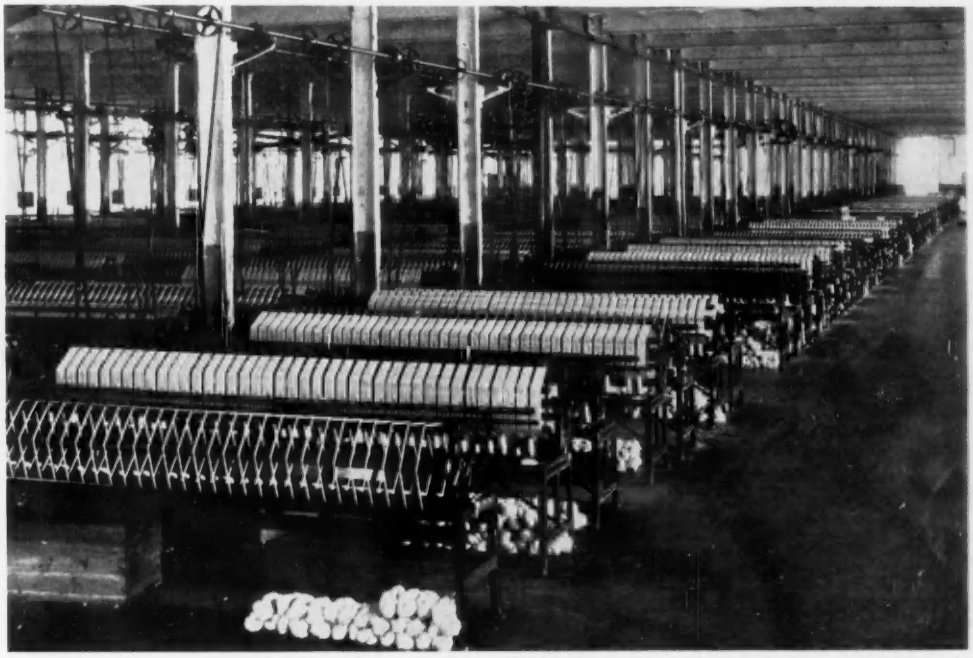

FIGURE 54.—A contrast to the native weaver. One of the big cotton factories in Madura which absorbs much rural labour. (Courtesy of Indian Trade Commissioner.)

These regions, prior to the introduction of tea and coffee plantations were mostly unpopulated jungle with here and there scattered hamlets growing a little rice or millet on clearings in the forest. No communications touched them; they were entirely self sufficing. Coffee cultivation was introduced into the region in the mid-18th century, and

it is now an area of great coffee or tea estates owned and run by Europeans and worked by native labour, a state of affairs found nowhere else in South India. When it was found that coffee was a profitable industry, both natives and Europeans turned mainly to its cultivation, the Government making large grants of land in the jungle for the purpose, and there existed side by side the extremes of agricultural production—the small native proprietor growing his rice crop and a few coffee trees on his tiny holding in a very crude manner, and the large European proprietor running his estate with native labour, and up-to-date scientific cultivating methods far in advance of the native.

These regions, therefore, are areas of large landed proprietors. In Coorg as typical there were in 1911, 94 estates of which 83 were owned and run by Europeans and in the Nilgiris which is one of the most wholly English regions of South India the plantation owners numbered 40,509 out of a total population of 75,575. The labourers together comprised almost 84 per cent of the population, which shows the plantation methods of cultivation very typically. Much of the labour has to be brought from the coastal regions which provide a very fruitful area for recruiting. It is, however, not so easy to maintain the labour on the estates as might first appear, since in many parts not only are the natives averse to forest conditions, being plainsmen, but the malarial ravages are also great, and are one of the great factors militating against the development of these areas. Some of the estate work is done by resident coolies and extra labour is obtained for work during the busiest seasons. Labourers usually arrive at the estates about July and return to their own affairs and crops about September. Then in November there is a fresh influx which does not ebb till the harvest is gathered in February, March, and April so that the population figures vary considerably at different periods of the year.

That this type of rural economy can exist in South India in spite of the fact previously mentioned, that the land belongs to the native and large commercial cropping by white people is not possible, is due to the particular conditions in these hill regions, which are found nowhere else in India save on the Himalayas in the North where the same type of economy finds a place.

These hill lands are practically uninhabited, and if not taken over by Europeans would in all probability remain unpopulated, since as previously stated, the lowland peoples dislike the jungle, and are frightened by the malarial conditions which are rife. Hence, in allowing the white people to cultivate these lands the Government is not acting in any way detrimentally to native interests. In fact it is to the benefit of the regions, since it means additional revenue to the district, and more work for the surplus labouring population of the plains, who, returning to the plains after the coffee harvest, bring a little money to these poor and debt-ridden rice lands. Furthermore, it is quite probable that were these regions left to be developed by the native, they would never be developed at all, for not only does the clearing of the land and the founding of the plantation require a large outlay of capital which the native does not have, but it is very doubtful whether even with the money and knowledge, he would have

the energy, perseverance, and hard-working qualities which the European coffee planters have had to maintain under the most trying conditions in establishing their plantations. It must be remembered that the earliest of them went into virtually virgin forest land, miles away from any habitation, with no communication whatsoever with the world outside save through forest tracks almost impossible to traverse. Further, the regions were ridden with malaria which the white man was first to catch owing to his being unaccustomed to the climate. Again, he had to cope with most unsatisfactory labour conditions—coolies brought from the coast who not only disliked but feared the gloomy forest country; who contracted malaria and died off like flies; who would desert in numbers if they felt inclined, and who, owing to their poor physique and insufficient nourishment were most inefficient labourers. Finally the terrible solitude of the earliest planters must be recalled—perhaps one or two white people alone in the dense and wild forest country with a handful of native labourers, to whom they had to act as masters and doctors, and with no other white people within a very wide range, they fell ill themselves and were left to the mercies of the ignorant natives.

Such was the type of the earliest planter, and it is unquestionable that had this task been left to the natives, there would have been no tea or coffee plantations in South India, and one of her most profitable sources of revenue would have gone.

The profitability and prosperity of the plantation system, though a blessing in the unpopulated jungle, would be an unadulterated evil on the plains, for to turn over the land which belongs to the native and on which he grows his food to a commercial system which would no doubt be profitable, would be against all the ideals which the British administration of India has set before it. The only course which can be taken, and that in only those regions where pressure of population is not excessive, is to educate and assist the ryot to grow a commercial crop as far as his land will permit without detriment to his food supply.

PRODUCTION REGION 7

Cotton, Jowar, Wheat, Pulse

The final association of the plains to be discussed and the only one in which rice does not find a place is the cotton-jowar-wheat zone of Surat, Broach, and Baroda which is a continuation of the rich cotton-jowar-wheat-linseed zone of the plateau in the valleys of the Khandesh and Berar, the only variation being that linseed is absent. The reasons for this association are the deep, black, heavy soils of the region and its low rainfall as compared with the country to the south. The soils are due to the Tapti and Narbada rivers, while the low rainfall as compared with the country to the south is due to the termination of the Western Ghats south of the Tapti, allowing the rain-bearing winds to blow up the valleys of Khandesh and Berar, so eliminating the concentration of rain on the coast. The cotton and jowar crops are grown in rotation during the Kharif season, and owing to the exceptionally good soils and rainfall conditions, the crops here are of very high quality and yield, the Broach and Surat cotton being second only to that of South Madras in quality. The growth of wheat as a rabi crop in this area is explained by the fact

that these soils are sufficiently deep and retentive to conserve the moisture necessary to bring the wheat crop to maturity. Wheat is always a rabi crop since the temperatures are too high for it during the summer, and also the rains cause a blight on the crop even were the temperature suitable.

This cotton-jowar-wheat zone is terminated very abruptly to the south by the sudden rise in rainfall due to the Ghat barrier and by the presence of the lighter lateritic soils wholly unsuited to the crops in the association.

This region is a prosperous one for it has a sound food basis and a double commercial crop basis. In spite of this latter fact the emigration from these areas is not as great as from the rice plains since the population is not so great. The main emigration is a temporary one to the cotton mills of Bombay and Surat. The fact that this is temporary and that the population is not forsaking the country for the town is proved by the following figures from the last census. In 1891 out of every 1,000 persons in this region, 659 persons lived in places below 2,000 inhabitants. The corresponding figure for 1921 was 650. This means that the small agricultural village has not appreciably lost ground in thirty years and the prospect of Western India passing from a mainly agricultural to the mainly industrial condition as in England is very remote.

If this is true of the cotton districts of Broach and Surat, it is even more true of the Southern districts of the Peninsula where there is not only very little raw material basis for industry (cotton, hides, and oilseeds being about the only ones, and minerals being a negligible factor), but power is also difficult to obtain. Even waterpower, which is the basis of so much industry in Bombay, is not available in Madras owing to the slower rivers and the fact that the water is required for irrigation. Moreover, much of the commercial prosperity of the Bombay region is due to the Marathas and Parsees who seem to possess an aptitude for commercial undertakings not possessed by the wholly Dravidian peoples of the South.

CONCLUSION

The survey of the plains, though they are richer regions than the plateau has endorsed the conclusions arrived at in the Deccan study, that with the Indian ryot, food must come first. Commercial cropping still progresses; already it has been a benefit in many areas, but the care for the future must be that the area under commercial crops shall not be extended at the expense of the food area. If the commercial area is to be extended (and this is very probable in many districts), and increased production is required, the remedy must be sought in the improvement of existing methods of cultivation. Agricultural departments are doing what they can to improve the breeds of cattle, which in their present state cannot work efficiently. They are further encouraging the growth of fodder crops which are a sad deficiency in the rice country and are making efforts towards getting cheaper supplies of fertiliser for this much cropped land. They are undertaking seed distribution and marketing so that good crops can be grown and fair prices received for them. The Government of India has initiated many schemes for loans to agriculturalists for land improvement.

Can it be hoped that the combination of native skill and Western science may make India the type of producing country which she hopes to be—one growing sufficiently to support her many millions at a decent standard of comfort and with a surplus of produce to export as a source of income for her national expenses?

THE BALANCED ECONOMY OF ST. JOHN ISLAND

Earl Shaw

A CLOSE adjustment of population and industry to geographic environment is not characteristic of many countries in the world today. Some sections are overpopulated for their resources; others, well supplied with valuable raw materials, are too sparsely populated for advanced industrial development; and few may be found where number and type of population, nature and amount of resources, and character and stage of industrial development all appear to harmonize. St. John (Figs. 1 and 2), the smallest of the three Virgin Islands of the United States, closely approaches this accordance. It is the purpose of this article to explain the reasons for St. John's adjustment, and to describe in a general manner the relationship of industries to environment.

St. John, with an area of approximately 20 square miles and a population of 761 colored and 4 white people has not always shown an even balance among settlement, resources, and industries. True, during the early days under Danish rule, the island flourished with the other Virgins in the production and sale of sugar (Fig. 3). European markets remained high for many decades and profits were easy in spite of rugged topography (Fig. 2) and inadequate rainfall. Then came a series of events that upset St. John's economic equilibrium. The first was the invention of new processes for extraction of sugar from beets; the second, an enlarged production of cane from East Indian regions; and the third, the emancipation of the Danish slaves in 1848. These decisive blows destroyed the reign of sugar in St. John and started the economic unsettlement which has almost disappeared today.

St. John was not as well fitted to meet these changes in the sugar industry as the other two Virgin Islands.[1] Her lands were no less arable than those of St. Thomas, but when hoe-culture sugar became unprofitable in the latter island, the shipping business, though starting to decline, ably cushioned the shock. St. John could not gain a share of this commerce although Coral Bay, which borders a portion of the eastern coast line, is conceded to be even a better harbor than that of St. Thomas. Several factors account for the failure of a shipping development on St. John. The eastern island was settled later than St. Thomas; the latter is nearer Virgin Passage and Puerto Rico; and the famous old St. Tho-

[1] However, the other islands have not approached the economic equilibrium of St. John. St. Croix is overpopulated for the dwindling sugar business, which is giving way to cattle raising; and St. Thomas has too many people for her present shipping trade. Denmark surely took advantage of an opportune time to sell the Virgins to the United States. They cost the government a war price and are a constant source of expense. Whereas the outlay for Alaska was less than two cents an acre; for Nevada, Colorado, and Utah less than three cents an acre; for the Louisiana Purchase approximately four cents an acre; for the Philippines less than fourteen cents an acre; and for the Canal Zone $35.80 an acre, the Virgin Islands cost the United States $295.00 an acre, or a total of $25,000,000. Moreover, the financial drain has not stopped there. The yearly federal expenditures have averaged over one-third of a million dollars for the sixteen years of ownership, and the annual appropriation for each of the last three years has approximated a half million. The most of these annual payments has gone to balance the budgets of St. Croix and St. Thomas, while St. John has required but little help.

mian port had ample capacity for all shipping which came. Moreover, the position of Coral Bay with reference to the mountains of Tortola, the British island to the northeast, where guns of heavy calibre could be mounted and thus jeopardize a fleet, may have discouraged port expenditures.

Again, the uplands of St. Croix are as maturely dissected, or more so, than the uplands of St. John. Yet between the eastern and western hills of St. Croix there lies a gently rolling Tertiary coastal plain which lends itself well to plow cultivation, so necessary for economical sugar production in a labor crisis and period of sharp competition.

St. John had neither shipping nor arable land when sugar ceased to yield profits with free labor and an unfavorable physical background. Consequently, during the decades following emancipation there has been a proportionately larger emigration than from either of the other isles. A comparison of the population statistics for the three islands during the last century will bear this out. In 1835 St. Thomas had 14,022 people; today her population is 9,834, which represents a decline of 30 per cent. In 1835 St. Croix had a population of 26,681; today it numbers 11,413, showing a loss of 57 per cent. In 1841 St. John had 2,555 people; today they number 765, a decline of 70 per cent. St. Croix has by far the greatest numerical loss, but St. John shows the largest proportional decline. (Figures from the United States Census.) Moreover, the outward movement was considerably faster than that from the other Virgins, for all but 10 per cent of St. John's loss took place within forty years, and during the last half century population has been relatively stable. In short, St. John has long since made

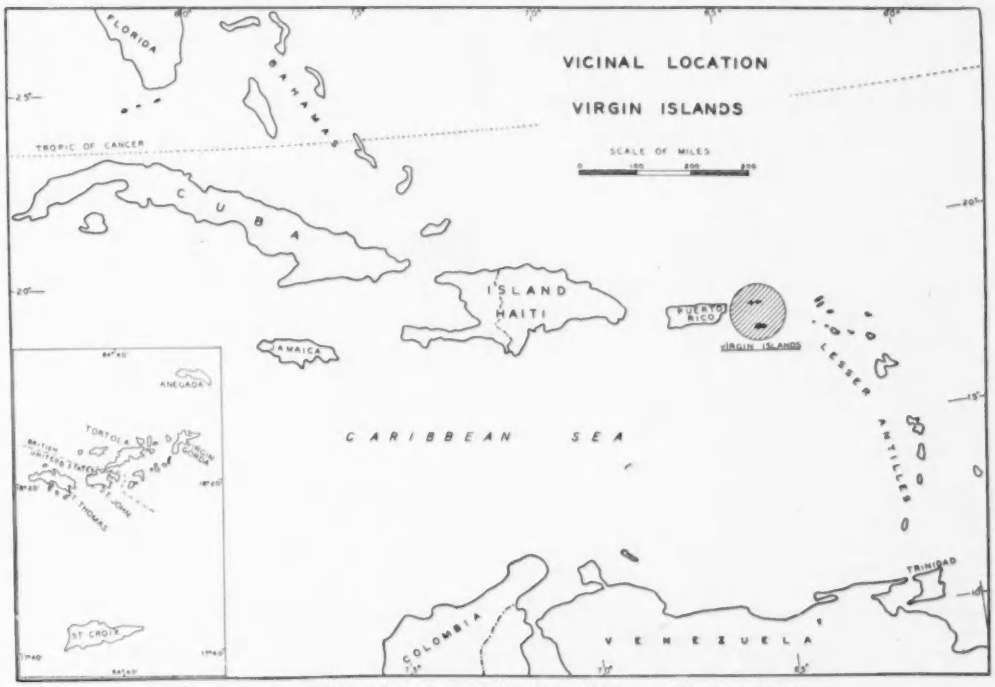

FIGURE 1.—Vicinal location of the United States Virgin Islands.

the adjustments from an economy based on sugar to one which depends on more diversified yet primitive pursuits. These include the grazing of cattle, a small production of forest products, a widespread practice of sustenance farming, and a minor interest in fishing. All such occupations have requirements that differ strikingly from the intensive sugar culture which preceded them. Their development involves contrasted geographic factors.

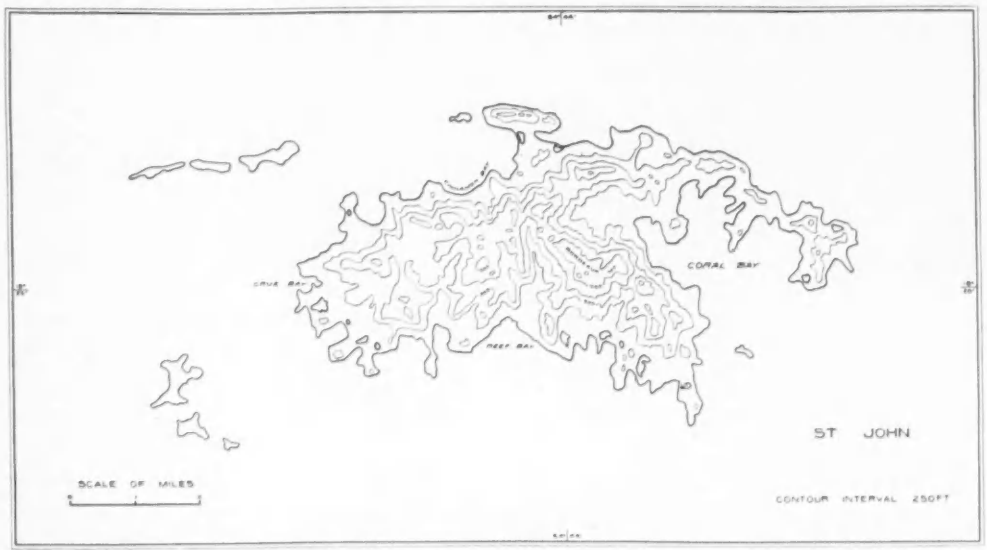

FIGURE 2.—A mountain backbone extends across St. John in a general east-west direction. The topography is rugged, and scarcely five per cent of the island could be classed as arable land.

CATTLE RAISING

Cattle raising is a major island industry. Whereas sugar growing in colonial days demanded large numbers of laborers, but few are involved in the cattle business. There is no cultivation, no careful planting, no hoeing, no harvesting, and no process of manufacture in the raising of beef cattle in St. John. Little labor is needed to plant the fields of improved grasses once in several years, to clean out the brush growth once or twice annually (if it is done at all), and to look after other limited requirements of this extensive type of occupation. Moreover, there is no need for the skilled labor so necessary in some highly developed lands. Hence, the sparse and unskilled population affords adequate labor supply. Again, St. John's rugged topography, which inhibits machine cultivation of sugar, does not prevent the growing of improved grasses (Fig. 4); and the latter are better adapted to the moderate and erratic rainfall characterizing the island than any cultivated crop that might be planted. Several other environmental features are favorable.

a. Low latitude and low altitude bring about a temperature which permits year-round grazing.
b. In the east and northeast, pastures of Guinea Grass provide succulent feed.
c. Fencing materials are easily obtained, for the forests which cover nearly 80 per cent of the land provide a convenient post supply. In

FIGURE 3.—The ruins of an old-fashioned sugar mill. The few which remain form a picturesque feature of the St. John landscape.

some instances live fencing may be seen, a characteristic feature of many places in the tropics.

d. Except in times of extreme drought, shallow wells dug in the alluvium above the impervious rocks furnish ample drinking water for stock.

e. The industry is largely in the hands of a few operators who are financially able to carry on to the best advantage. In the past they have imported high-grade sires from the temperate areas to cross with the Zebu and Senegal strains which make up their herds. At present there is a tendency to improve the breeds by careful selection of native types.

f. Puerto Rico has been and promises to continue a profitable outlet.

Although the factors listed suggest an advantageous background, St. John, like other tropical cattle areas, has a number of significant drawbacks. Drought periods, tick and fever hazards, constant care of the pastures to keep them from reverting to brush, a single market, and the small size of the industry (there are but 1,600 head of cattle on the island) hamper consistent progress. However, in spite of these obstacles, business shows signs of expansion and will continue to be a major economic development.

FOREST PRODUCTS

The gathering of forest products is a characteristic occupation of forested tropical regions where the population is sparse and unskilled. With cattle raising, it ranks as a major industry in St. John. The tree crop for which the island is most widely known is that of bay leaves. Through some unknown cause the indigenous *Pimenta acris* (Fig. 5) has developed naturally without intermixture with other but closely related species that yield an inferior and almost worthless bay oil; and it is largely because the bay leaves are obtained from this desirable species that the oil of St. John long has had an enviable reputation in the world's perfumery and cosmetic trade. Some ascribe the widespread occurrence of *Pimenta acris* to a peculiar adaptability of the soil, but there is no general acceptance of this belief.

The industry is not a plantation occupation. Hence, like cattle grazing, bay leaf gathering requires but few laborers from the island's small population. No attempt is made to

FIGURE 4.—Guinea Grass pasture on St. John. Several hundred acres of this succulent grass are grown.

plant the trees, but birds eat the bayberries and, with the wind, are scattering agents for the seeds. Plants spring up and, if the land owner wishes to encourage a favorable tree growth, other vegetation is cleared from the new seedlings. The few native families who perform this work, pick the leaves and assist in other tasks incident to the industry, are permitted by the land owner to occupy little plots of ground where they build rude huts and where they supplement the small bay leaf income by raising fruits and vegetables for their own sustenance.

Bay leaf gathering and manufacture is not the large development that may be supposed. It employs little labor and the annual sales probably amount to less than five thousand dollars. Although there are four stills, only one, slightly more modern than the other primitive types, is operating intermittently. There are hundreds of acres of bay trees growing up in brush, but new markets and better methods of production are needed to bring about significant expansion.

Besides bay oil, the forests contribute other products to island economy. The natives make charcoal (Fig. 6) for home use or for sale in small quantities to St. Thomas and St. Croix. The workers cut fence posts which are sold in a limited amount either locally or to neighboring islands. Basketry and similar articles are fashioned for sale in St. Thomas. Finally, several wild fruit and nut trees, at times, furnish a supplementary item to the regular native diet. However, there is no market for an increased production of any forest crops—no prospect of a wide expansion demanding more workers in the industry. Hence, there is no basis for large numbers of people, and thinly settled St. John is well adjusted to this pioneer activity.

SUSTENANCE FARMING AND FISHING

Sustenance farming is practiced by almost every family in St. John. Some depend on subsistence crops

FIGURE 5.—Bay trees on Bordeaux Mountain. Three-fourths of the bay trees of St. John are found on Bordeaux Mountain. The underbrush has not been cleared from the trees.

almost entirely to maintain their low standards of living, while others plant these crops to supplement the limited income received from other sources. Several vegetables grow well, and plots with tannias, okra, cassava, yams, pigeon peas, sweet potatoes, and beans are planted along with Cavendish bananas, papayas, and a few other tropical fruits.

The sea contributes an abundance of fish to the food supply. Submarine banks surround the island and, together with numerous bays and inlets formed by geologic submergence, make an ideal environment for fish and lend to the ease of their capture. If further variety in diet is desired, the negro may raise some chickens, keep a few pigs and, if very industrious, he may manage to purchase a cow to provide milk for his family.

Thus, sustenance farming and fishing furnish food without much labor. Moreover, the warm temperature makes fuel unnecessary except for cooking, and the forest cover supplies wood and charcoal, as well as the materials for a crude hut. Clothing gives but little worry, for protection from cold is not needed, and the simple attire of the native is very inexpensive. Like the young children in other tropical lands, many youngsters go naked most of the time. On the whole, the problem of eking out an existence in St. John is not a difficult one for the small population of today. It might have been possible for those

FIGURE 6.—Charcoal burning, long a characteristic industry in all the Virgins, is now most important in St. John.

who left the island when sugar declined to have remained and accepted a slightly lower standard of living than that prevailing in St. John at present. But this would have involved harder work on the part of the native and a more intensive development of the meagre island resources. The negroes do not like to work hard, and, added to this, many of the sugar workers found difficulty in adjusting themselves to emancipation and to the necessity of earning a living at tasks other than cane cultivation. Moreover, in the tropics even as in the temperate zone, there are those venturesome individuals who are anxious to move on at the call of some new and more attractive offer; and no doubt these comprised a majority of the emigrants. Some went to the other Virgins to take the places of cane workers who were leaving St. Croix, and of urban dwellers leaving St. Thomas; some went to more remote Caribbean lands, to sparsely populated Santo Domingo with its expanse of fertile fields; and still others, after a few decades, migrated to continental United States. With each significant emigration, the island offered a slightly easier life to those who remained, until today the people of St. John are making but little complaint about existing conditions. Fishing, sustenance farming, the gathering of forest products and cattle raising provide the population with the absolute necessities of life with a minimum effort; and like most tropical people, St. John folk make life's necessities the major goal.

The government is attempting to attract tourists to this isolated, primeval land (Fig. 7). Were it closer to densely populated regions and nearer to much travelled trade routes there might be some chance for success. Many world travellers would be intrigued by its primitive culture, lack of roads, rugged trails, forest cover, white sand beaches, and beautiful views. But an influx of tourists might upset the present balance. There would be a change in the cultural environment, a rise in the standard of living, an immigration of workers, and a development of economic desires among the natives which at present they do not sense and even then would find difficult to satisfy. Hence, it is a question whether it would be better to encourage a change or to let things remain at the present level—a status in which type and number of population, nature and amount of resources, and character and stage of industrial development all seem to be in fairly close adjustment—in some ways an adjustment ideal.

FIGURE 7.—St. John mail boat. St. John is an isolated island. Situated off the regular routes of trade and with no cable connections, the mail boat twice a week affords the only regular touch with the outside world.

AGRICULTURAL REGIONS OF NORTH AMERICA

Part XI—The Columbia Plateau Wheat Region

Oliver E. Baker

IN THE Pacific Northwest there are two areas scarcely of sufficient size or importance to deserve recognition as agricultural regions, yet so distinct from adjacent regions as to require separate description. These two areas have been called the Columbia Plateau Wheat Region and the Okanogan Highlands-West Kootenay Hay and Dairying Region.[1] The Columbia Plateau was originally a grassland region, like the Great Plains far to the east, with a rainfall increasing in amount from west to east, as on the Plains. The summer temperatures are like those in the Spring Wheat Region of the Dakotas and Montana, but the winter temperatures are similar to those in the Winter Wheat Region of Kansas, Oklahoma, and Colorado, and both spring and winter wheats are grown. The Okanogan Highlands-West Kootenay area was originally mostly forested and in climatic conditions resembles the Hay and Dairying Region of the Northeastern States and southeastern Canada. If it were adjacent, it would be included with this latter region. The agriculture is characterized by hay and pasture, fruit and forest products, dairying, poultry, and egg production.

THE COLUMBIA PLATEAU WHEAT REGION

The Columbia Plateau Wheat Region is mostly a dry-farming area, with some almost humid farming along its eastern margin. It differs mainly in size from dry-farming areas farther south along the western slope of the Rocky Mountains, which have been included in the Grazing and Irrigated Crops Region. The Columbia Plateau Region contains probably ten times the acreage of dry-land grain as the aggregate in these minor districts to the south, which would, if adjacent, be fittingly classified with it. It includes an area of about 18,000,000 acres, approximately 60 per cent of which is in the state of Washington; 28 per cent in Oregon; and 12 per cent in Idaho.

The characteristic crop of the region is wheat, as the name indicates. It constituted, in 1929, nearly 80 per cent of the total acreage of crops harvested. The wheat is grown, except in the almost humid portions, in alternation with summer fallow, in order to conserve the moisture and soil fertility of two seasons for one crop. The acreage of "idle and fallow" land reported by the Census in 1929 was, therefore, almost equal to that of the wheat harvested, and in the Oregon section exceeded the wheat acreage. There is some irrigated land in the region, about 158,000 acres in 1929, but this is less than 4 per cent of the acreage of crops harvested. This irrigated land is located mostly in the canyons and

[1] This Okanogan Highlands-West Kootenay area was not indicated as a distinct region in the Map of Agricultural Regions of North America, published in the October, 1926, issue of Economic Geography, but was hastily and inaccurately included with the Forest and Hay Region of Northern Canada.

valleys of the Snake and Columbia rivers, in which the climatic conditions resemble those in the Grazing and Irrigated Crops Region more than those on the Columbia Plateau. The irrigated crops are principally alfalfa, fruit, potatoes, and vegetables. Some alfalfa and fruit is also grown without irrigation in the sub-humid portions of the region, but characteristically the Columbia Plateau is a region of dry-land wheat, grown on large farms and seeded and harvested by large-scale machinery.

PHYSICAL CONDITIONS

From the standpoint of location and topography, the Columbia Plateau Wheat Region should be a part of the Grazing and Irrigated Crops Region, like the Snake River Plains to the southeast, but it receives too much moisture to be so classified, and, in addition, the evaporation is generally lower than in the Snake River Plains and similar sections of the Grazing and Irrigated Crops Region.

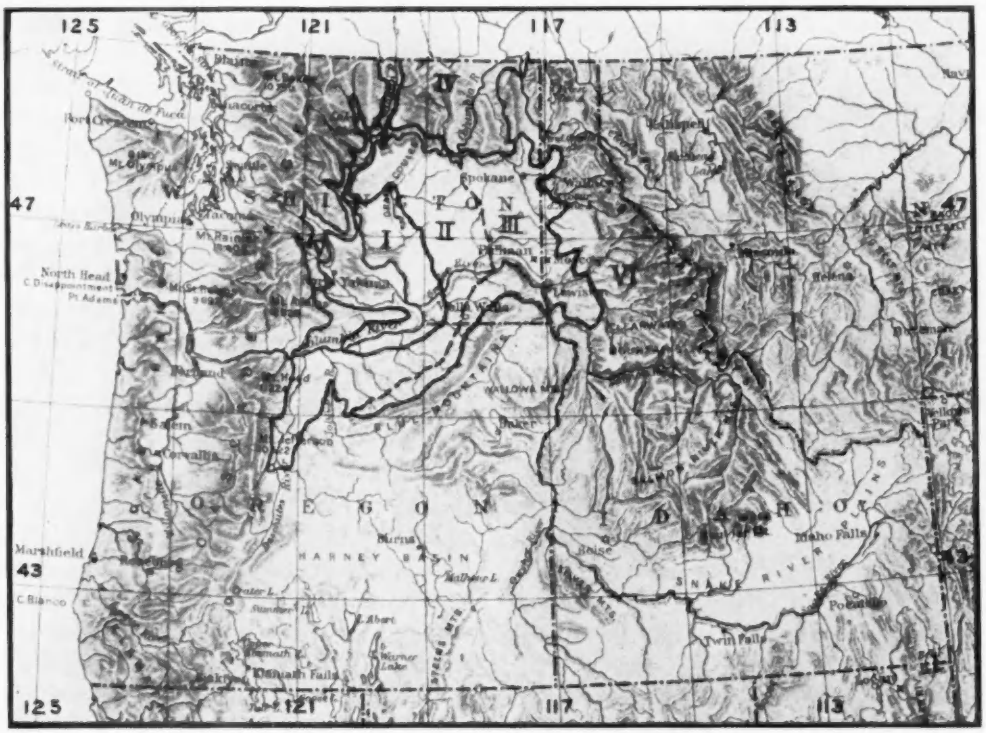

FIGURE 334.—The Columbia Plateau Wheat Region lies between the Rocky Mountains on the east and the Cascade Range on the west, the Blue Mountains on the south and the Okanogan Highlands on the north. It consists of a sub-humid to humid section, characterized by dark brown to black soils, marked III on the map, and a semi-arid section, characterized by medium-to-light-brown soils, marked II. The section marked I is desert, where the rainfall is so low that crop production without irrigation is normally unprofitable. It has been excluded, therefore, from the Columbia Plateau Wheat Region, although it is physiographically a part of the Plateau. The area marked IV on the map is part of the Okanogan Highlands-West Kootenay Hay and Dairying Region. (The map is a portion of the base map of the United States prepared by F. J. Marschner, of the U. S. Bureau of Agricultural Economics, for use in the "Atlas of American Agriculture.")

BOUNDARIES

On the east the region is bounded by the forested foothills of the Rocky Mountains; on the south, by the Blue Mountains; on the north, by the Spokane River and the Columbia River, which flows along the edge of the plateau. A small area above the north bank of the Columbia River and east of the Okanogan River has climatic and soil conditions similar to those of the Columbia Plateau. Some wheat is grown despite remoteness from the railroad. On the west, the region is bounded by the Columbia River as far south as Wenatchee, where the boundary, here determined by aridity rather than topography, turns east and then south along the Grand Coulee, and continues southward across the western portion of Adams and Franklin counties, following the Esquatzel Coulee, whence, after crossing the Snake River Canyon, it enters western Walla Walla County (Fig. 334). The two western townships in this county are too dry for profitable crop production. In Oregon there is a dry zone near the Columbia River, which narrows toward the west. The slopes that rise above this dry zone as far as the Blue Mountains to the south and southeast are part of the Columbia Plateau Wheat Region—the eastern portion, one of the most productive parts. This belt along the northern slope of the Blue Mountains extends westerly to the foothills of the Cascade Range. Across the Columbia Valley, in Klickitat, Yakima, and Benton counties, Washington, there is a similar but much smaller upland, a portion of which is called the Horse-Heaven Country, devoted largely to wheat. These upland and adjacent dry-farming lands to the west, beneath the Cascade Mountains, have been included within the Columbia Plateau Wheat Region.

CLIMATE

The climate of the Columbia Plateau Wheat Region is affected by both continental and marine influences, but the continental dominate. The ranges of the Rocky Mountains to the east protect it to some extent from the cold waves that frequently sweep over the interior of the Continent yet temperatures as low as 20 and 25 below zero have been recorded, while temperatures exceeding 100 degrees are reported every summer from some station in the region and in some summers from nearly all stations. However, "owing to the dryness of the air the heat is rarely oppressive and prostrations seldom occur."[2] The Cascade Mountains, on the west, likewise serve as a barrier against the moist and mild marine climate of the Pacific Coast. Nevertheless, the precipitation comes mostly in the late fall, winter, and spring months, as on the Pacific Coast, rather than in the summer, as on the Great Plains to the east, in the interior of the Continent. The region is arid along the western border, in Washington; semi-arid in the central Washington section and on most of the plateau south of the Columbia River, in Oregon; and sub-humid to humid in the eastern Washington and in most of the Idaho portions; also along the foothills of the Blue Mountains. The major causes of the variation in moisture conditions have been briefly explained as follows:

"The prevailing moisture bearing winds are from the southwest and

[2] Hunter, Byron; Severance, Geo.; and Miller, R. N. "A Review of the Agriculture of the Big Bend Country," Washington Agricultural Experiment Station, Bul. 192, 1925, p. 12.

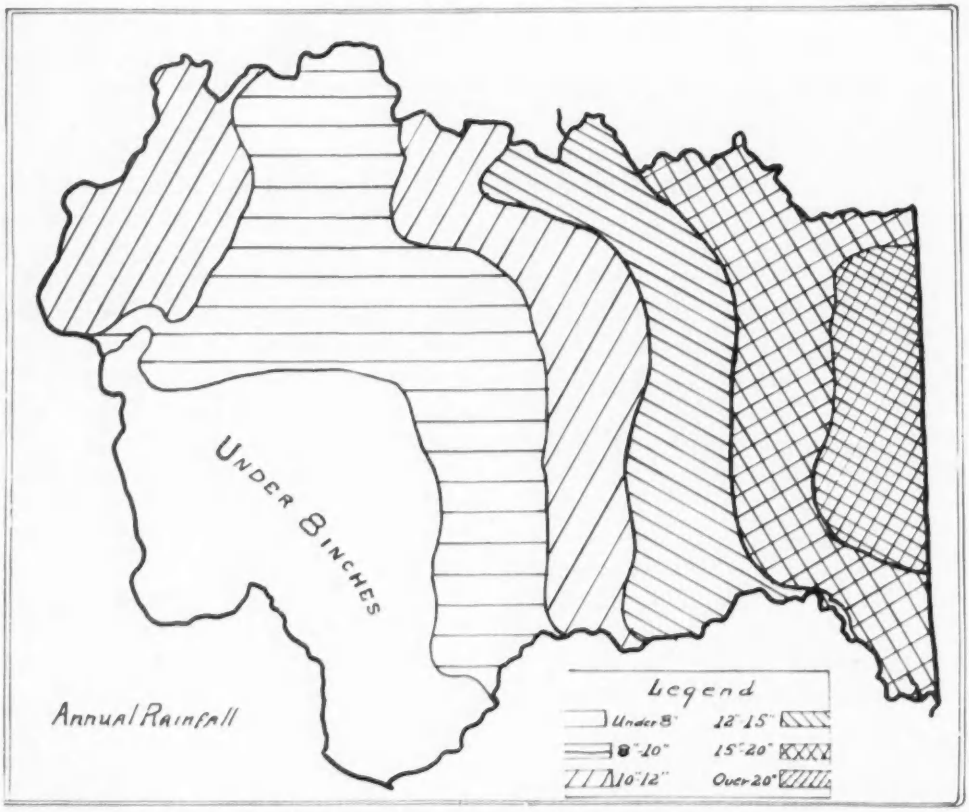

FIGURE 335.—This annual precipitation map of the "Big Bend" counties, Whitman County, and a portion of Spokane County, Washington, shows the increase in precipitation from west to east, with increasing altitude. Increasing altitude also accounts for the westerly trend of the isohyetal lines in the north central portion of the Columbia Plateau, and for the heavier rainfall on the "Waterville Plateau" in the northwestern corner of the "Big Bend Country." The map was prepared by Professor J. Wright Baylor of the University of Washington, and was published in the October, 1931, issue of the *Journal of Geography*. (It is reproduced through the courtesy of Professor Baylor and Professor George J. Miller, editor of the *Journal of Geography*.)

west. In passing over the Cascade range, the air currents lose much of their moisture, it being precipitated as snow or rain on the western slope of the mountains. In descending the eastern slope of the Cascade range into the valleys below, the air becomes warmer and much drier. Its capacity for holding vapor continues to increase until the low elevations along the Columbia River are reached where the average annual precipitation is between 6 and 7 inches and where there is a preponderance of dry air, clear sky, and heavy evaporation during much of the year. As the winds pass in a northeasterly direction from the Columbia River to the higher altitudes of the Big Bend Plateau, the air becomes cooler and its capacity for holding vapor is gradually reduced. This results in a more or less regular increase in the annual precipitation as the elevations increase."[3]

The annual precipitation ranges from 8 or 9 inches, on the average, along the arid margin, beyond which crop production has been found to be

[3] Hunter, Byron; Severance, Geo.; and Miller, R. N. "A Review of the Agriculture of the Big Bend Country," Washington Agricultural Experiment Station, Bul. 192, 1925, p. 12.

unprofitable, to about 25 inches, and in places possibly 30 inches, along the mountain margin on the east and south (Fig. 335). Owing to the occurrence of the rainfall largely in the winter and spring, when evaporation is low, and to the practice of summer fallowing, grain is grown along the arid margin of this region on a smaller precipitation than elsewhere in the United States, except, possibly, in California; where the crop is produced during the cool, moist winter. "The precipitation comes in the form of both rain and snow. Most of it, however, is rain and the showers are seldom torrential. Very little water is lost as surface run-off except when rain falls or snow melts on a frozen surface."[4] In the moister eastern portion of the region, this statement, made with reference to the Big Bend country, requires qualification. There is occasionally considerable run-off.

From 30 to 40 per cent, or more, of the precipitation is received in the three winter months, the proportion increasing toward the west; and from 20 to 30 per cent during the spring months. Wide variations, however, occur from year to year (Fig. 336). The winter precipitation ranges from an average of about three inches along the arid margin of the region near the Columbia River, in central Washington, to 8 and 9 inches along the foothills of the Rocky and Blue mountains. During the spring the rainfall ranges from one or two inches along the desert margin, to about 8 inches along the mountains. The summers are dry, with a rainfall ranging from about one inch along the Columbia River to 4 inches or more in some seasons near the mountains. But in autumn the rainfall increases again, usually in late autumn, and averages for the three months about 2 inches near the Columbia River and from 6 to 8 inches along the mountain foothills. The normal snowfall is 20 inches in the drier and warmer portions of the region along the Columbia and Snake Rivers and 60 inches, some years even more, along the mountain front. Snow covers the ground in the average year from 25 days or less in the lower warmer valleys to 50 days and more along the foothills of the mountains. The first snowfall comes usually early in November.[5]

In the Columbia Plateau region, as in all semi-arid to sub-humid climates, average rainfall figures may be misleading, not only because of the wide variations from year to year, but also because the region experiences prolonged periods of both high and low precipitation. At Lind, Washington, for example, the annual precipitation during the seven crop years 1900–1906 ranged from 11.4 inches to 15.3 inches; whereas, during the six crop years 1917–1922 the range was from 6.6 inches to 8.1 inches. Similarly, at Rosalia, the average annual precipitation during the period 1897–1903 was 21.7 inches and during the period 1917–1924 was only 15.7 inches. But periods of high and low precipitation, as pointed out by Mr. Hunter, do not occur uniformly over the country. Many storms are local in character.

The quantity and seasonal dis-

[4] Hunter, Byron; Severance, Geo.; and Miller, R. N. "A Review of the Agriculture of the Big Bend Country." Washington Agricultural Experiment Station, Bul. 192, 1925, p. 15.

[5] "The amount of precipitation that comes as snow may have a very important influence on crop production. In the first place much of the precipitation that falls as snow may be lost as surface run-off provided the snow melts rapidly on a frozen surface. In the second place a blanket of snow is an effective protection to winter wheat during severe cold weather." *Ibid.*, p. 19.

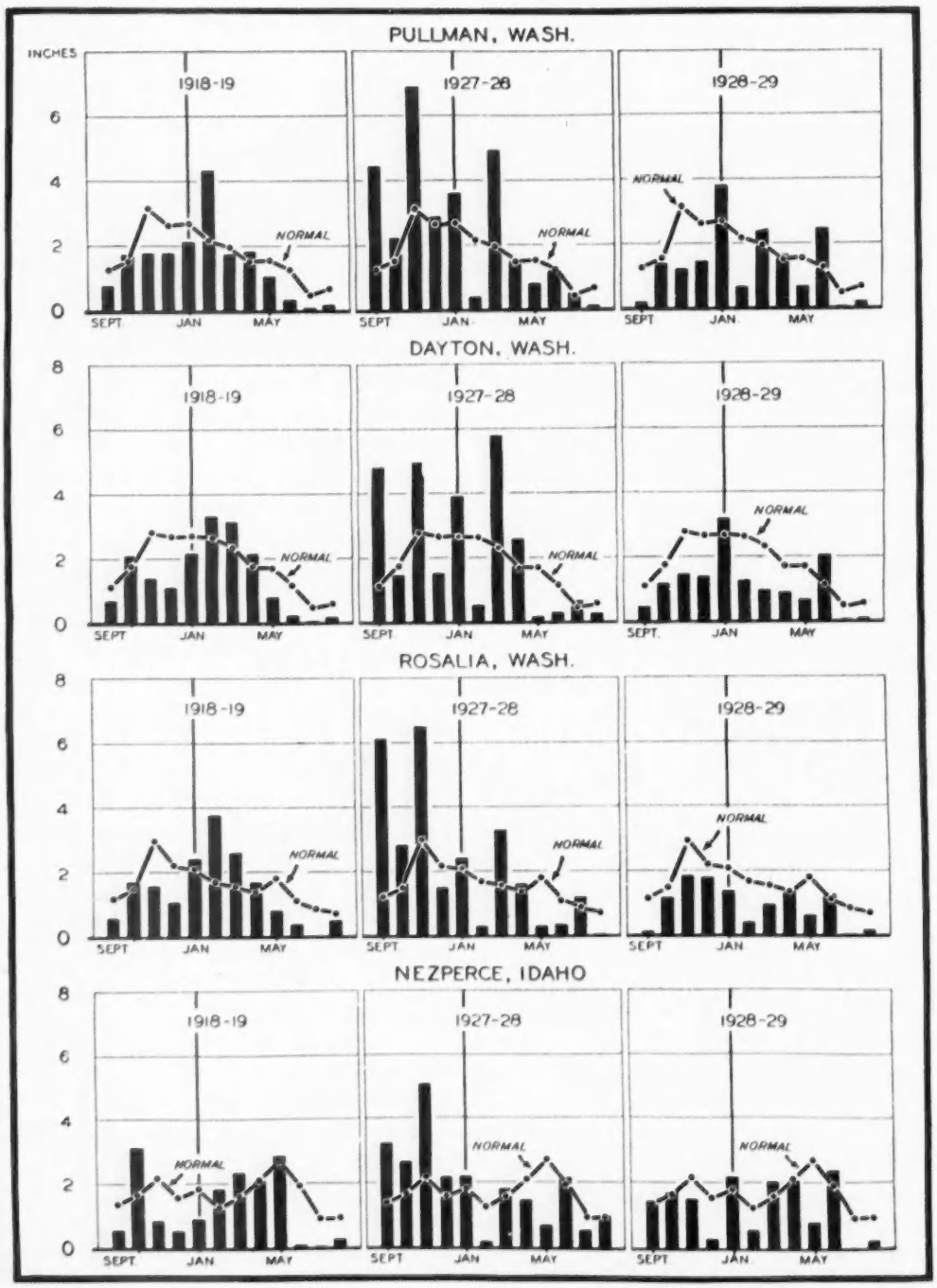

FIGURE 336.—Monthly precipitation at four stations on the Columbia Plateau, moister eastern portion, during three seasons. The heaviest rainfall occurs in the late fall, winter, and early spring, but there is a wide variation from year to year in the quantity received each month. At Pullman, Washington, for example, November is normally the wettest month, but in the seasons 1918–19 and 1928–29 much the heaviest precipitation came in January. July and August are practically always very dry everywhere in the region and only a little rain is received in June and September. (The graph is from "Farming Systems for Eastern Washington and Northern Idaho," Bul. 173, Idaho Agricultural Experiment Station, also Bul. 244, Washington Agricultural Experiment Station, 1930, by George Severance, Byron Hunter, and Paul Eke. It is reproduced by permission of Mr. Hunter.)

tribution of the precipitation is the dominant factor in determining the yield of wheat, and, as wheat is the major source of income of the people, the precipitation, with normal wheat prices, exercises a dominant influence also upon the general economic condition in the region.[6] In Table I the wheat yields of the three large farms located near the Hatton weather station are compared with the annual precipitation and with the rainfall in April, May, and June. "Very low yields, it appears, are usually associated with low annual and low April, May, and June precipitation. Observe, for example, the average yields and the precipitation for the years 1924, 1922, and 1918. Very high yields, on the other hand, are generally associated with good April, May, or June rains and a fairly good annual precipitation. May and June rains are even more important than annual precipitation. Yields, it should be understood, are greatly influenced also by other climatic factors such as temperature, evaporation, cloudiness, and winter killing."[7]

The summers on the Columbia Plateau are fairly cool, averaging 62 degrees along the foothills to 70 degrees at the lower levels. In the low, dry valleys of the Columbia and Snake rivers the mean temperature for the three months exceeds 70 degrees, and throughout the region temperatures as high as 104 or 105 degrees occasionally occur. "If these high temperatures occur when the supply of soil moisture is very low and just before the crop is matured, considerable damage usually results from the burning of the grain."[9] On the other hand, light summer frosts sometimes occur in depressions and basins along the Rocky Mountain margin. The winters are moderate, the mean temperature for the three months ranging from 25 degrees in the foothills to 35 and 37 degrees in the lower valleys. However, temperatures below zero may be expected each winter, and occasionally the

TABLE I

AVERAGE YIELDS OF ALL WHEAT (WINTER AND SPRING) ON THREE FARMS NEAR THE HATTON WEATHER STATION[8]

Year	*Total Acres in Wheat*	*Average Yield per Acre (Bushels)*	*Annual Sept.–Aug.*	*Rainfall in Inches*			
				April	*May*	*June*	*April–June*
1915	2390	32.0	10.54	1.65	1.48	.71	3.84
1916	2440	19.8	13.59	1.24	.59	1.09	2.92
1917	3400	18.6	8.79	2.22	1.47	.18	3.87
1918	3400	7.8	7.18	.06	.32	.15	.53
1919	3260	18.9	8.63	1.07	.40	.00	1.47
1920	2440	14.2	9.52	1.70	.51	.67	2.88
1921	3880	17.4	9.03	.54	.23	.23	1.00
1922	3290	6.7	7.38	.67	.06	.19	.92
1923	4200	25.7	10.04	.64	.85	2.92	4.41
1924	4195	8.0	7.74	.06	.03	.40	.49

[6] "During periods of high precipitation, crop yields are considerably above the average and, if wheat prices are good, the country as a whole is usually prosperous. During such times credit is easy to obtain and many farmers become overoptimistic and mortgage their farms to buy more land and equipment. Low grade lands that are suitable only for grazing purposes are also brought into cultivation. When a series of scant rainfall years comes, on the other hand, crop yields are generally low, credits are contracted, and farmers are usually hard pressed financially. Especially is this the case if wheat prices are also low. A combination of low yields and low prices forces the abandonment of low grade lands." *Ibid.*, p. 23.

[7] *Ibid.*, p. 27.

[8] "It is very probable that the yields shown in Table I are considerably above the average for that part of the country. The men who furnished the information are considered excellent managers, the three farms are well situated, and it is believed they are above the average in productiveness." *Ibid.*, p. 27.

[9] *Ibid.*, p. 23.

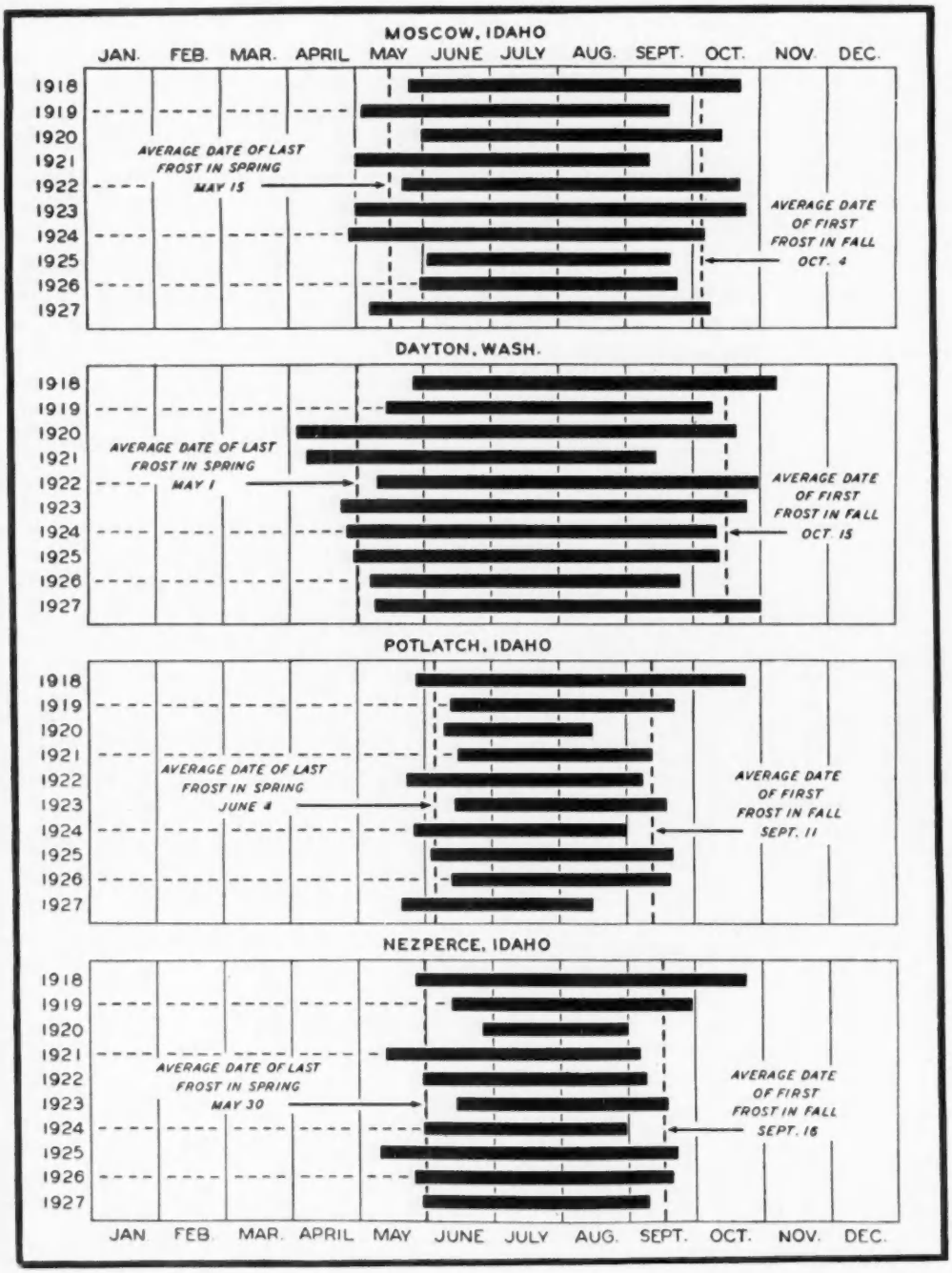
MOSCOW, IDAHO
JAN. FEB. MAR. APRIL MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
1918
1919
1920
1921
1922
1923
1924
1925
1926
1927
AVERAGE DATE OF LAST FROST IN SPRING MAY 15
AVERAGE DATE OF FIRST FROST IN FALL OCT. 4
DAYTON, WASH.
AVERAGE DATE OF LAST FROST IN SPRING MAY 1
AVERAGE DATE OF FIRST FROST IN FALL OCT. 15
POTLATCH, IDAHO
AVERAGE DATE OF LAST FROST IN SPRING JUNE 4
AVERAGE DATE OF FIRST FROST IN FALL SEPT. 11
NEZPERCE, IDAHO
AVERAGE DATE OF LAST FROST IN SPRING MAY 30
AVERAGE DATE OF FIRST FROST IN FALL SEPT. 16

FIGURE 337.—Frost-free period at four representative stations in the eastern portion of the Columbia Plateau Wheat Region. Potlatch is only a few miles from Moscow, but adjoins the forest on the eastern foothills of the Plateau. Nevertheless, it is more representative than Moscow of the length of the frost-free season in the northern and eastern portion of the Region. (The graph is from "Farming Systems for Eastern Washington and Northern Idaho," Bul. 173, Idaho Agricultural Experiment Station, by Severance, Hunter, and Eke.)

thermometer falls to 10 and even 20 below. "These cold waves sometimes seriously injure winter wheat provided the ground is not covered with snow. If the cold spell has been immediately preceded by relatively mild weather during which the wheat has made some growth, the injury may be even more serious. Such was the condition in December, 1924, when practically all winter wheat in the Big Bend Country was ruined."[9]

In the winter the average daily range in temperature is only 12 to 15 degrees, like that in the Pacific Coast region, but in summer the range is as great as 30 and even 35 degrees. The last killing frost in spring occurs during May, except in the river valleys, where it is earlier; and the first killing frost in fall usually occurs in late September or early October (Fig. 337). The frost-free season averages 100 to 120 days in length in the higher portions of the Plateau in eastern Washington and Idaho; but in the Snake River Canyon and adjacent slopes, also along the Columbia River below the mouth of the Snake, it exceeds 180 days.[10] It is a pleasant sight to stand with one's feet in snow on the edge of the Plateau south of Pullman or Moscow and look down upon the peach orchards in bloom on the floor of the Snake River Canyon nearly 2,000 feet below.

[9] *Ibid.*, p. 23. (See footnote 4, p. 171.)

TOPOGRAPHY

The Columbia Plateau is one of the most extensive lava flows in the world. The lava is mostly basaltic; and the canyons of the Columbia and Snake rivers and of the Grand Coulee show between the successive lava flows beds of volcanic dust and lapelli, soil formations, and even an-

FIGURE 338.—Gently rolling land characteristic of the central portion of the plateau in Washington. Summer-fallowed field in the foreground, farmstead with windbreak in the distance, trees and bushes along the intermittent stream course. (Photo by E. D. Strait, Courtesy of U. S. Bureau of Agricultural Economics.)

[10] "The lower the altitude in the Big Bend area, the earlier can farm work begin in the spring and the earlier will crops mature. For this reason crops grown at low elevations frequently have a better chance of escaping the burning effect of hot waves, for they occur over the whole area at the same time." Hunter, Byron; Severance, Geo.; and Miller, R. N. "A Review of the Agriculture of the Big Bend Country." Washington Agricultural Experiment Station, Bul. 192, 1925, p. 25.

cient tree stumps and logs. The plateau slopes gently upward in all directions from about 300 feet elevation above sea level at the junction of the Columbia and Snake rivers and westward along the Columbia, or 500 feet on the bluffs above, to 3,000 or 3,500 feet elevation on the foothills of the mountains to the east and south. Most of the plateau in Washington and Oregon is between 1,000 and 2,000 feet elevation, but in the northwestern section of the "Big Bend Country" (northern Douglas County), and in the Spokane and eastern Palouse sections of eastern Washington (much of Spokane and Whitman counties), also in most of the Idaho portion and in the foothills of the Blue Mountains in Oregon, the plateau rises above 2,000 feet. These more elevated sections are also the moister portions of the region.

Streams from the mountains cross the higher portions of the plateau and flow into the Columbia and Snake rivers, but in the central Washington portion of the plateau, the rainfall is only sufficient to produce intermittent streams that drain into small lakes located in the Grand and other coulees. This central portion of the plateau is characterized by a level to rolling surface, which becomes more rolling toward the east (Figs. 338 to 341). The topography in the Palouse and Walla Walla sections is peculiar, the large rounded knolls having a steeper slope to the east and north than to the west and south, somewhat resembling sand dunes in shape. The "Palouse country" has been described in the following words by Fenneman in his "Physiography of the Western United States": "The district has a rolling surface of broad rounded wavelike swells, rising generally 20 to 80 feet above valleys, which contain neither streams nor channels. Here and there in the northern part are isolated buttes of older rock, outliers of the Idaho mountains, rising abruptly above the lava plateau. The type of these is Steptoe Butte, an

FIGURE 339.—Wheat field on farm of W. E. Benedict near Pullman, Wash. This field yielded 46 bushels per acre. The altitude of the Plateau is somewhat higher and lay of the land more rolling than that shown in Figure 338. Note farmstead is located in the "valley," where water can be obtained from a well, and wind is less severe. (Photo by E. D. Strait, Courtesy of U. S. Bureau of Agricultural Economics.)

FIGURE 340.—View near Moscow, Idaho, 12 miles east of Pullman, looking toward the foothills of the Rocky Mountains. The lay of the land is still more rolling than near Pullman. Increasing rainfall is indicated by the larger windbreaks and occasional clump of trees on the upland. Note the farmstead in the valley and the size of the fields. (Photo by E. D. Strait, Courtesy of U. S. Bureau of Agricultural Economics.)

isolated quartzite mountain rising 1,000 feet above the plain in the heart of the wheat country midway between Lewiston, Idaho, and Spokane, Washington. From the summit the vast wheat fields are seen stretching away in all directions 'like a stormy sea.' Only the eastern shore of this sea can be seen. It is made by the mountain border in Idaho with its jutting promontories, like those of a sunken coast. 'Each level-floored inlet and embayment is yellow with grain, and each headland dark with pines.' The explanation of this rolling topography is bound up with that of the soil."

SOILS

The soils of the Columbia Plateau, particularly of the Palouse and Walla Walla sections, are extraordinarily fertile. Normally the highest acre-yields in any non-irrigated wheat region in the United States are in eastern Washington. To quote again from Fenneman: "It (the soil) is very fine textured and deep, at places 50–75 feet, with an almost total absence of any kind of stones. Its fine texture (silt) causes it to be exceedingly retentive of moisture. It absorbs moisture so rapidly that there is no direct run-off from the greater part of the area. Russell speaks of slopes of 25 or 30 degrees which are not marked by rills or gullies either in the natural state or when plowed and left fallow for a year."

It was formerly believed that these soils were derived from the underlying basalt, but now, as Fenneman notes, "There is ample evidence that it (the soil) is an accumulation of wind-borne dust, probably from the more arid region to the west and southwest. Not only does this supposition agree with the loess-like character, but it has also been shown that the chemical composition is not what could be expected from the decomposition of the underlying basalts. . . . Locally (and generally buried) there is a true residual soil

FIGURE 341.—Near the foothills of the Rocky Mountains northeast of Moscow, Idaho. Note the house is on the upland but the orchard is protected by the windbreak of tall trees. (Photo by E. D. Strait, Courtesy of U. S. Bureau of Agricultural Economics.)

grading downward into basalt. Elsewhere are occasional sedimentary deposits like those of the 'lake beds' farther west."

That this resistance to erosion was owing in part to the humus content and other characteristics of the soil assignable to the grass vegetation is indicated by the fact that now, after 40 years of cultivation, and consequent depletion of the organic matter in the soil, (one third of the organic matter and one-fourth of the nitrogen has been lost), erosion is becoming severe in many places (Figs. 342 and 343). In this connection the following excerpt from a press release of the U. S. Department of Agriculture is of interest: "Snowdrift erosion is the most recently discovered soil thief in the United States, . . . (It) occurs chiefly in the Palouse winter wheat region of eastern Washington, western Idaho, and northern Oregon, although it is also a problem in other western areas, including parts of Utah.

"To have sufficient moisture and fertility for a wheat crop, the Palouse farmers summer fallow their land one year and crop it the next. The snow drifts onto the steep leeward fallowed slopes during the winter and in the spring when it melts it washes down soil with it. The problem is especially bad because at the time of the spring thaws the soil is still loose from the previous season's plowing and cultivation and it erodes easily. Erosion is heaviest on northerly slopes because the drifts are deepest there and because the surface soil is not frozen when this melting occurs.

"This gradual erosion has lowered the wheat yields on the higher slopes. . . . Cultivation of the higher slope of these rolling farm lands may have to be abandoned and the land put into sweet clover or some other crop that will hold the soil. If nothing is done to check the erosion, the higher land will eventually become worthless. Not only that, but in the later stages of erosion worthless subsoil is washed down on top of good topsoil and ruins additional land."

The two principal soil series of loessial origin in the region are the Palouse, characteristic of the more humid eastern portion of the region, and the Ritzville, which are lighter

colored soils characteristic of the semi-arid sections. Both are grassland soils. Where the loess has been deposited under climatic conditions that have permitted the growth of forest, the soils are classified in the Helmer series, which are lighter colored than the grassland soils, and have a much lower organic content. The land values in 1917 were reported at $75 to $150 for the Palouse silt loam and $50 to $100 for the Helmer.

The Palouse soils are "dull dark brown to nearly black in color and friable. The subsoils are lighter brown to yellowish brown in color, compact in structure and underlain by a tawny-yellow substratum of fine textured material without evidence of stratification."[11] The Palouse series includes a sandy loam, fine sandy loam, loam and silt loam, of which the last is the most extensive and typical of the region. The surface soil is about 10 inches deep and of darker color than the subsoil, which appears of slightly heavier or finer texture, apparently because of the lesser organic content. "The type is non-calcareous within the 3-foot section in typical areas. The soil mantle is typically underlain at depths ranging from a few feet to 50 feet or more by basalt, but it overlaps on areas of granitic and schistose rocks."[11] In spots erosion has exposed the subsoil, which, owing to the deficiency of organic matter is "difficult to handle and in some seasons quite unproductive."[11] In other places, particularly near the drier western margin of this soil, "lenticular masses highly impregnated with accumulation of lime leached from the overlying materials"[11] have been exposed by erosion. "Wheat ordinarily yields 10 to 35 bushels per acre, but 50 bushels have been reported in some cases."[11]

"The Ritzville silt loam is a light-brown, compact silt loam of uniform texture to a depth of 6 feet or more.

FIGURE 342.—Erosion on a 40 per cent slope (40 feet rise in 100 feet horizontal distance) in summer fallow, following an extraordinarily heavy rain on July 30, 1931. Many of the small gullies go to the depth of plowing. (Courtesy of Pacific Northwest Erosion Experiment Station, Pullman, Washington.)

The underlying material is of similar character and extends to basaltic bedrock, which is encountered at a depth of 50 to 100 feet or more. The soil is 12 to 15 inches deep, although this depth is arbitrarily assumed and is not based on distinct changes in color, texture or structure. Even the slight amount of moisture present in the soil under ordinary field condi-

[11] Van Duyne, Cornelius; and others, "Soil Survey of Spokane County, Washington," U. S. Dept. of Agriculture, 1921, p. 35, 87 and 88.

tions emphasizes the brown color. Dusty or dry exposed surfaces are grayish. The light brown color of the upper subsoil undergoes a slight but gradual change between 24 and 36 inches, and the lower subsoil is a lighter grayish brown to brownish gray.

"This type is easily cultivated. The surface quickly absorbs all the rainfall and much of the water from melting snow, so that very little moisture is lost through run-off and evaporation. Owing to the compact structure of the type, water does not sink rapidly beyond the reach of plants, and a large part of the scant precipitation is available for the use of crops. . . .

"This type formerly supported a cover of sagebrush and bunch grass. As a rule the sagebrush was smaller and more scattered, and the growth of bunch grass thicker and more luxuriant than on the lighter textured soils in the western part of the country.

"Nearly all this type either is or has been in cultivation. The original cover of bunch grass remains only on portions too steep and rough for farming. Such areas are used for grazing. Wheat is the money crop and is used also for feed. Only a small acreage of rye is grown. Potatoes, vegetables, and fruit are produced for home use. The farms of this type generally are large. Summer fallowing is universally practiced. This is the principal wheat-growing soil of the county. The yields of wheat range from a few bushels to 35 bushels per acre, depending on the season. A large acreage of this type formerly farmed

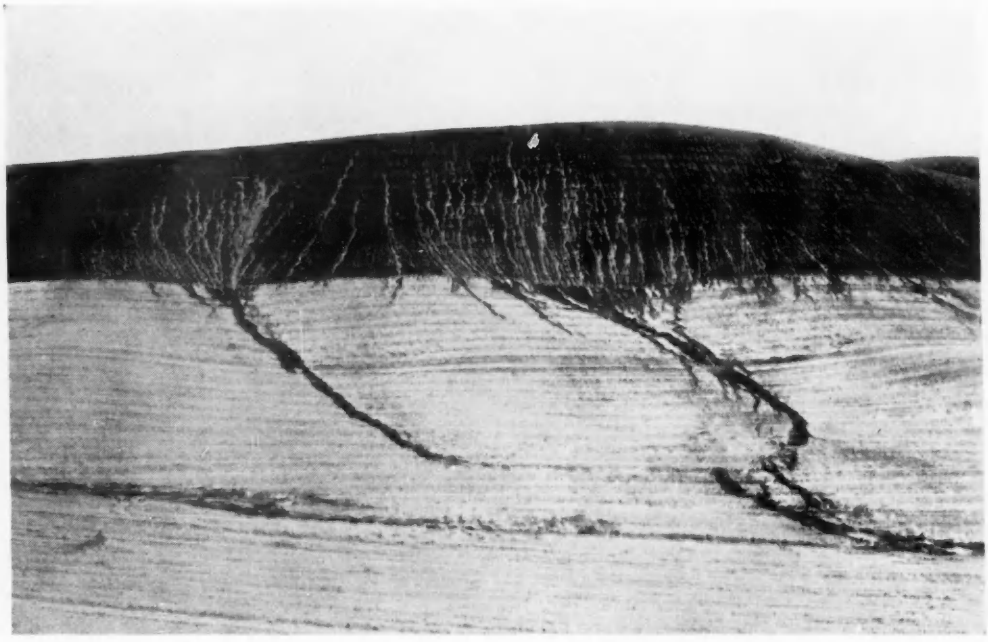

FIGURE 343.—Erosion following the heavy rain of July 30, 1931, showing the partial protection afforded by the wheat stubble. The upper slope, with its myriad erosion channels, is summer fallow, while the lower slope was in wheat cut a few days before the rain. Note in places the deposition of soil on the stubble. (Courtesy of Pacific Northwest Erosion Experiment Station, Pullman, Washington.)

to wheat is now abandoned and supports a growth of Russian thistle, mustard, and other weeds."[12]

These Ritzville soils, particularly the silt loams and very fine sandy loams, are usually well supplied with calcium, potash, and phosphorous. Nitrogen and organic matter, however, are frequently deficient. Along the arid margin of the Ritzville series of soils, in Franklin, Adams, Grant, and Douglas counties, particularly on the sandier type of soil, there is much soil blowing and drifting. Such soils must be farmed with particular reference to preventing this serious loss. Even soils in the moister sections to the east blow and drift in dry years, if not properly handled.[13]

In the semi-arid section of the Columbia Plateau, extending from Spokane westward and southwestward, there is, according to Fenneman, ". . . a type of erosion topography in some respects unique, not known to be exemplified elsewhere in the United States or equaled elsewhere in the world. The parts thus characterized are known as scablands. These are strips of bare or almost bare basalt, roughly eroded and generally channeled by canyons known as coulees. As each strip of scabland throughout its width has been eroded to a lower level than that of the remaining original surface, and as the vertical-walled channels within each strip are numerous and intersecting, the term coulee is not always applied to one particular gorge but is sometimes used to designate an entire strip of scabland. The strips themselves merge here and divide there, forming a net-like pattern, enclosing remnants of the original plateau surface. This is true of all except Moses Coulee, the most western of all, which is isolated midway between Grand Coulee and the Waterville Plateau. The total area of scablands is at least 2,000 square miles or one-fifth of the district here considered.

"In general these coulees traverse the district from northeast to southwest. They represent approximately the normal drainage lines of the present day but more accurately the lines of Pleistocene drainage. Most of them now carry water rarely if at all. These coulees and scablands result from erosion by glacial streams of great volume and steep gradient escaping from the ice-covered area to the north. As the plateau in its larger aspect was smooth but in detail rough, these great streams spread widely, dividing, subdividing, and reuniting in web form and stripping the mantle rock from broad belts. Within the web or between the great strips are remnants of the original surface, preserving the loess cover and the mature drainage pattern of the Palouse country."

Fenneman, speaking particularly of central Washington, notes,—"Water for domestic purposes is hard to obtain and often of poor quality. The deep and firm-textured soil, exceedingly retentive of moisture, gives up water very slowly to surface wells which are sunk from 30 to 50 feet

[12] Van Duyne, Cornelius; and others, "Soil Survey of Franklin County, Washington," U. S. Dept. of Agriculture, 1917, p. 48 and 50.

[13] "From the best available information, the areas that blow are increasing slowly. As the land is farmed year after year the vegetable matter decays and the fiber that binds the soil particles together is gradually destroyed. In this way the soil becomes easier to pulverize and its resistance to the wind grows less and less. Most of the abandoned farms are located in the areas which are more or less subject to blowing. Soil blowing, however, is not the chief cause of land abandonment." Hunter, Byron; Severance, Geo.; and Miller, R. N. "A Review of the Agriculture of the Big Bend Country." Washington Agricultural Experiment Station, Bul. 192, 1925, p. 11.

deep. Moreover, the soil of a semi-arid country quickly yields soluble salts which make well waters unpalatable. In many communities water has been hauled 10 to 15 miles in tank wagons and stored in cisterns for domestic use." In the more humid Palouse section, to the east, good water is obtainable from wells almost everywhere.

and 3,100,000 acres, or 20 per cent, was lying idle or fallow, doubtless nearly all summer fallow. It appears therefore, that about half the farm land was used for crop production. Since only 434,000 acres were reported as plowable pasture, it appears that nearly all the potential crop land was in crops or fallow in 1929. Except at the sacrifice of

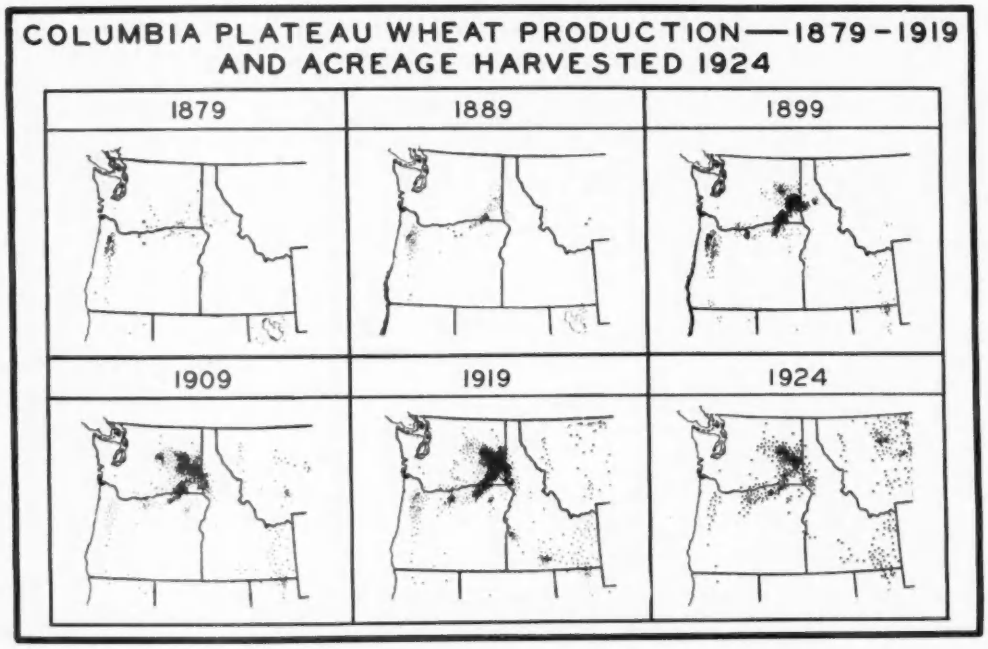

FIGURE 344.—A little wheat was grown in the vicinity of Walla Walla before the Civil War, but production was small as late as 1879. By 1889 wheat production was developing rapidly in the Palouse Country, and the producing area had extended westerly from Walla Walla along the slopes of the Blue Mountains. In 1899 production was heavy in both the Walla Walla and Palouse districts, and the wheat area had expanded into the Big Bend Country, particularly into Lincoln and Adams counties. By 1909 the conquest of the region by wheat had become practically complete. Heavy production may be noted on the "Waterville Plateau." By 1919 the production had become denser, doubtless stimulated by the high price of wheat, but in 1924, owing to lower prices and a dry season, the wheat area had thinned considerably, particularly in the drier portions of the regions. After 1924 the acreage in wheat gradually increased, until 1931, but has not quite reached the level of the post-war period.

LAND UTILIZATION

Of the 18,200,000 acres of land in the Columbia Plateau wheat region, about 15,200,000 are in farms. Of this farm land 4,100,000 acres, or 27 per cent, was in crops harvested in 1929, 200,000 acres were crop failure, summer fallow, there is little opportunity, apparently, for expansion of crop acreage. The area of non-plowable pasture was nearly 6,000,000 acres and of woodland in farms about 1,000,000 acres, most of which is pastured. The acreage of land used for pasture is, therefore, almost

as large as that used for crops, but it is doubtful if the value of the pasturage is one-tenth that of the crops.

THE CROPS

Wheat is the principal crop, as previously noted, constituting four-fifths of the total crop acreage harvested in 1929. The acre-yield during the past decade has averaged about 20 bushels. It should be recalled, however, that two acres of land and two years of tillage are required to produce one acre of wheat. There was a slight decline in acreage between 1919 and 1929, practically confined to the semi-arid section of the region in Washington (Fig. 344). The acreage of hay crops constituted 13 per cent of that of all crops. Two-thirds of the hay acreage was grain hay, in part wheat which it did not pay to thresh. Probably wheat constituted, therefore, seven-eighths of the total crop acreage. In no other extensive portion of the United States is a single crop so dominant, except possibly in Vermont and New Hampshire where hay is grown almost exclusively.

Alfalfa was grown on about four per cent of the crop land of the Columbia Plateau Wheat Region in 1929, timothy and clover on one per cent, while wild hay was cut on another one per cent; oats, grown mostly in the more humid eastern portion of the region, occupied about two per cent of the crop land, and barley nearly as large an acreage. In the moister eastern section of the region, there were about 50,000 acres of peas in 1929, principally in Spokane County (about 7 per cent of the crop land), in Whitman County (about 4 per cent), and Latah County, Idaho (about 6 per cent). There is a little sweet clover for pasture in nearly every county of the region. Fruit was grown on one per cent of the crop land of the region, but the acreage is mostly concentrated in a few districts, while potatoes and vegetables jointly occupied a half of one per cent. The acreage of irrigated land slightly exceeded that of alfalfa, and doubtless most of the fruit acreage also was irrigated.

PASTURE

The Columbia Plateau was originally a vast area of rolling grassland. Nearly all this grassland, where climate, topography and soils permitted, has been plowed up and put into wheat alternating with fallow. The more humid the climate, the larger the proportion of the pasture area that has been plowed. In the sub-humid eastern Washington and Idaho portions plowable pasture constitutes only about 6 per cent of the tillable area, whereas in the semi-arid Big Bend counties the proportion is 15 to 20 per cent. In this semi-arid section there is, likewise, a larger proportion of non-tillable pasture, doubtless in part scabland and in part land with soils unsuited to dry-farming practices. From one-third to one-half and even more of the farm land in the drier counties is classified as non-tillable pasture. In the more humid eastern counties this proportion is generally one-sixth to one-third.

This pasture land is mostly bunch grass mixed with sage brush (*Artemesia tridentata*) in the western semi-arid sections, and mixed with scattering rose bushes, buck bush, and other shrubs in the more humid eastern sections. The principal grass is wheat grass (*Agropyron spicatum*). In the more humid sections the bunch grass becomes a sod, containing, "in addi-

FIGURE 345.—Plowing wheat stubble in the Big Bend Country. The front team contains 10 horses and pulls one 3-bottom 14-inch gang plow, while each of the other two teams contains 18 horses and pulls two 3-bottom 14-inch gang plows. A strip over 10 feet wide is plowed by the three teams. (Photo by M. L. Wilson, Courtesy of U. S. Bureau of Agricultural Economics.)

tion to wheat grass, the little bunch grass (*Festuca idahoensis*), poa (*Poa sandbergii*), and balsam root (*Balsamorrhiza sagittata*). During the early spring and summer this area presents a luxuriant and varied appearance, due largely to the prominence of plants with large, showy flowers and leaves. The rainfall is from 15 to 25 inches."[14] In the drier western sections of the region, or where the soil is less able to hold available water, due to its shallow or rocky character, this grass presents an open, bunch-like appearance. The wheat grass is here, also, sometimes mixed with poa and conspicuous herbaceous plants. This type marks the transition from the wheat grass sod to the sage brush desert. It occurs in areas receiving from 9 to 15 inches of annual precipitation, on the average.

The carrying capacity of the pastures varies from 50 acres per cow or steer along the arid margin of the region to about 20 acres in the Big Bend Country and eastward almost to Spokane, while in the more humid sections of eastern Washington and Idaho and on the slopes beneath the Blue Mountains, only 5 to 15 acres are required to carry a cow. Much of the range is used as year-long pasture. The carrying capacity of the range, particularly, in the drier portions of the region, has been greatly reduced by overgrazing.[15]

[14] Shantz, H. L., in Natural Vegetation section of the "Atlas of American Agriculture," U. S. Dept. of Agriculture, 1924, p. 17.

LIVESTOCK

The most important class of livestock in the Columbia Plateau Wheat Region is the work stock, mostly horses. Three-fourths of the 25,000 farms in the region reported horses in 1930, despite the fact that nearly

[15] "At the present time the open range consists of areas of rough or sandy country, which have never been plowed. The extensive areas of land which were once farmed and are now idle afford very little grazing, as the bunch grass returns to the fields very slowly. Many such areas should never have been broken, as they were not adapted to dry farming. They support only a growth of weeds, which are a menace to surrounding farms. The native bunch grass is very nutritious. Overgrazing has reduced the value of much of the range land, which is now used for grazing large flocks of sheep, passing back and forth from the summer range in the mountains to winter quarters in this and near-by sections.

"Cattle and horses, as a rule, are grazed within fenced areas; only a few are seen on the open range. . . . The animals graze on fields of native grass and on stubble land the greater part of the year and require very little care." Van Duyne and others in "Soil Survey of Franklin County, Washington." U. S. Department of Agriculture, 1917, p. 31.

FIGURE 346.—Weeding a summer fallow in the Big Bend Country. Three 12-foot rotary rod weeders are pulled by the 20-mule team. One man does the work of three men and covers 40 to 65 acres a day. (Photo by M. L. Wilson, Courtesy of U. S. Bureau of Agricultural Economics.)

four-fifths of all farms reported automobiles, that over one-third of the farms had auto trucks and one-sixth of the farms had tractors. That there were many farms in the region (362 in Spokane County alone) without either horses or tractors is explained by the Census definition of a farm which virtually includes every place that produces over $250 worth of agricultural products, or has over 3 acres of land. There are many such small places near the cities especially. The farms reporting horses and mules averaged ten head per farm. It is interesting to note in this area of typically large farms, the average area per farm is 600 acres, of which 166 acres is in crops and 120 acres in cultivated summer fallow, and the typical farm would be much larger than this, that the horse (or mule) was the sole source of power, in 1930, in plowing, seeding, and harvesting on five-sixths of the farms, and probably the principal source on many other farms. If any change has occurred in this proportion since 1930, it has been, probably, to increase the relative importance of horses, for many wheat farmers during the last three years of low prices could not afford to buy gasoline, whereas they could raise much of the feed for their horses. It should be noted, however, that the horse as a means of transportation has been replaced much more extensively than the horse as a source of power for plowing, seeding, and harvesting.

Cattle are more numerous than horses and mules in the region—274,000 of all ages as compared with 177,000 horses and mules—but the value of the cattle in a normal year is somewhat smaller. Cows kept primarily for milk production numbered, in 1930, less than one-fourth of all the cattle, but were somewhat more numerous than cows kept primarily for beef production. However, about 70 per cent of all the farms in the region reported dairy cows in the census, as compared with only 9 per cent reporting beef cows. The number of dairy cows, therefore, averaged nearly four per farm reporting, while of beef cows there were nearly twenty. The dairy cows are located mostly in the counties having cities and where the climate is sub-humid, nearly one-fifth of those in the entire region be-

ing in Spokane County and a fourth in Walla Walla and Umatilla counties. The beef cattle, on the other hand, are located largely on the cheaper land remote from the cities and where the climate is semi-arid, with extensive grazing available.

There were about 125,000 swine of all ages in the region on April 1, 1930, which gives 5 per farm for all farms in the region, but 17 per farm reporting. The swine, like the dairy cows, are located largely in the more humid portions of the region and near the cities. There were about 1,600,000 sheep and lambs in the region in 1930, concentrated on 3,500 farms, which is an average of nearly 500 per farm. Ranchers specializing in sheep usually have several times this number, the average being reduced by the farmers who keep a few sheep. The sheep, like the beef cattle, are found largely on the cheap land, which means in this region mostly dry land and land remote from the cities. Umatilla and Morrow counties, Oregon, which contain much dry land, and also irrigated areas where sheep are fattened, reported one-third of all the sheep in the region.

There were about 1,100,000 chickens in the region on April 1, 1930. One-fourth of these were in Spokane County and another fourth in Whitman and Umatilla counties. Chickens, like dairy cows and swine, are associated with the denser human population and the moister climatic conditions.

The relative importance of the animal industries in the region is indicated by the value of the products sold. In the Washington portion, which is a 60 per cent sample, the value of the livestock sold in 1929 was about $6,600,000 and of animal products sold about $6,000,000, as compared with $51,000,000 for crops sold, about 80 per cent of which was wheat.

Three-fifths of the farms sold livestock and three-fourths sold animal products. This ratio was even higher for the cash-grain farms than for the other types of farms, taken as a whole. Of the animal products sold, about 60 per cent were dairy products, 28 per cent poultry and eggs, and 12 per cent wool. However, the sales of poultry and eggs constituted only about 40 per cent of the production, consumption on the farms exceeding the sales. There was a large farm consumption of dairy products also. Nearly half of the eggs sold and over one-third of the milk sold were produced in Spokane County and doubtless were nearly all consumed in Spokane.

SYSTEMS OF FARMING AND SIZE OF FARMS

Although wheat constitutes 80 per cent of the acreage of all crops, less than half the farms in the Columbia Plateau Wheat Region are "cash-grain" farms, according to the recent census classification of type of farm. In travelling across the region there is little to be seen except wheat and summer fallow in preparation for wheat, yet in every county in the Washington portion, even the most arid, and probably in the Idaho and Oregon portions also, there are reported by the Census "crop specialty" farms, growing principally hay or potatoes, dairy farms, stock ranches, and "part-time" farms, and in every county except one there are fruit farms, located commonly in some canyon or cove, "animal specialty" farms, poultry farms, and "self-sufficing" farms. Even truck farms are reported in all except three counties. The Census figures are

impressive in showing a great diversity of agriculture in this region of exceptional specialization. The statistics reveal, moreover, how easy it is to overlook the little farm and the humble farmer, just as in the cities one fails to realize how numerous are the poor.

The large wheat farms, with their massive machinery and substitution of gasoline or horse power for human labor, dominate not only the landscape but also the economic organization of the region (Figs. 345 to 348). Taking the Washington portion of the region as a sample, the Census figures show that in 1929, of the $65,000,000 worth of farm products sold from farms or contributed by farms to the family living, about $40,000,000 was from the sale of crops by "cash-grain" farms, practically all wheat. The products sold from farms or consumed by the farm family averaged $6,230 in value for the cash-grain farms, and only $2,480 for all other farms. It is interesting to note also that cash-grain farms contributed directly to the family living produce averaging a greater value than the other farms, taken as a whole ($293 worth as compared with $255), and even more than was contributed by the "self-sufficing" farms ($210). As is the case with commercial agriculture in many other parts of the United States, the production of crops for sale is superposed on a system of farming in large part self-sufficing with reference to food.

FIGURE 347.—A combine harvesting wheat near Moscow, Idaho. It is being pulled by 20 horses, is operated by four men, cuts 12 feet, and harvests 20 acres a day. (Courtesy of U. S. Bureau of Agricultural Economics.)

The cash-grain farms in the Washington portion of the region averaged 1,100 acres of land per farm in the Big Bend Country, but less than 600 acres in the moister Palouse Country to the east. Only 400 acres per farm were harvested in 1929 in the Big Bend Country, on the average, and 250 acres in the Palouse Country and counties adjoining it south of

the Snake River. Since the pasture averaged less than 240 acres per farm in the drier counties and 110 acres in the moister counties, it appears that from a third to a half of the land in these cash-grain farms lay idle as fallow. The constant cultivation of the land for 35 to 50 years has reduced the organic matter in the soil by at least 35 per cent, and the nitrogen by 25 per cent with resultant reduction in the moisture holding capacity of the soil and increase in erosion.

Where the average annual precipitation exceeds 18 inches, which includes only a minor (extreme eastern) portion of the Columbia Plateau Wheat Region the farmers have been urged to use peas, sweet clover, or alfalfa in a cropping system with the wheat, in order to rebuild the organic matter and nitrogen content of the soil (Fig. 349). However, only a relatively few of the more progressive farmers have done so as yet, for the Census reports, in 1929, less than 40,000 acres of peas, practically all in Whitman and Spokane counties, and less than 1,500 acres of sweet clover pasture. There were about 50,000 acres of alfalfa in the Washington portion of the region, three-fifths in Whitman and Spokane counties, but it is doubtful if half the acreage in the region is grown in rotation with the grain crops. The area in legumes in these two counties and in the four counties in Idaho included in the region did not exceed 100,000 acres in all, in 1929, as compared with 1,000,000 acres of wheat and 110,000 acres of other grain. In the drier sections to the west, where the acreage of wheat is twice as large as in this moister portion, there are practically no leguminous crops grown, except alfalfa in the irrigated areas.

FIGURE 348.—A combine operated by a tractor cutting wheat on the farm of Arthur Cole, near Pullman, Washington. Note the wagon moving alongside the tractor and receiving the harvested wheat. (Photo by E. D. Strait, Courtesy of U. S. Bureau of Agricultural Economics.)

Wheat farming on the Columbia Plateau, despite soils originally as fertile as any in the Nation, if not in the world, appears to be going the way of wheat farming in Wisconsin and California, where, after 30 to 60 years of cultivation, yields became unprofitable and wheat production gave place largely to dairying, to fruit growing (locally in California), and to more general systems of farming. In the moister portions of the Plateau, where the legumes can be grown in rotation with the grain crops, the development of dairying and other livestock enterprises affords a solution to the problem. But in the Big Bend counties, except in the moister localities, no legume crop has yet been discovered that can be grown successfully in rotation with wheat. Fortunately, owing to the more level character of the land and less rainfall, erosion in this semi-arid section of the Plateau is less rapid than in much of the region to the east, but the maintenance of the organic matter in the soil will here

also become a pressing problem in the course of time. The expansion of grain production, particularly wheat, onto the semi-arid grasslands of the world (probably the most influential agricultural development of the past century), which was made possible by the invention and improvement of agricultural machinery, of well drilling appliances and of the railroad, seems likely to be short-lived beyond the moisture limits of leguminous crops that can be grown in rotation with the wheat or other grain, except where erosion, generally by wind, results in rejuvenation of the soil, and there only, of course, where the subsoil is fertile. In parts of the Big Bend country, a windstorm will sometimes remove nearly all the soil loosened by the plow, and happily, the loess subsoil is fertile, though lower normally in organic matter and nitrogen than the surface soil.

In view of the need of further development of other systems of farming than the dominant wheat and summer fallow system of the present day, it may be interesting to consider some of the characteristics of the other systems of farming in the region. General farms, using the Census classification, rank next in number, followed by fruit farms, part-time farms, and dairy farms. These four classes include nearly one-third of all the farms in the region. The remaining sixth (nearly half the farms in the region are "cash-grain" farms) consist of "crop specialty" farms (4 per cent of all farms), "truck" (vegetable) farms (3 per cent), poultry farms (3 per cent), "self-sufficing" farms (3 per cent), stock ranches (2 per cent), "animal specialty" farms (2 per cent), and a few "forest product," "boarding and lodging," and other minor types (Fig. 350).

General farms comprise those "where the value of products from any one source was less than 40 per cent of the total value of all products of the farm." Somewhat over six per cent of the farms in the drier counties were general farms in 1929, and 10 per cent in the moister counties. It is to be expected that, under the less restricted moisture conditions of the eastern portion of the region, the more numerous are the crops that can be grown and the greater the diversification of agriculture. Over two-fifths of the general farms in the Washington portion of the region are in Spokane County. Density of population (a large local market) and a relatively long growing season here supplement a heavier precipitation in inducing diversification. It is interesting to note, however, that in the dry county, Adams, in which there is very little irrigation, there were 19 general farms, and in Franklin County, even drier, but with some irrigated land, there were 27 general farms. The general farms are somewhat smaller in area than the "cash-grain" farms, averaging in the Big Bend counties 350 acres of land per farm, of which less than 50 acres were in harvested crops, while 180 acres were pasture, mostly non-plowable. In this semi-arid section these general farms are, apparently, mixed cash-grain and livestock farms. In the moister eastern section of the region the general farms averaged only 150 acres in area, of which only about 40 acres were in crops and somewhat less in pasture. This small crop and pasture acreage suggests a meager living. In Spokane County the average farm value of all products sold or used by the farm-

er's family on general farms was only about $1,400; but in Whitman County it was about $1,700. The value of products per farm in the semi-arid Big Bend counties is similar, lesser productivity per acre balancing the greater acreage. In some of these dry-farming counties, however, the value of products of general farms was little more than $1,000 per farm.

The fruit farms are mostly irrigated and are located principally on the periphery of the region, where water is available,—in Spokane County, on the margin of the Okanogan Highlands Region; in Douglas and Grant counties, mostly along the Columbia River and in the Grand Coulee, and belonging, therefore, to the Grazing and Irrigated Crops Region; and in Klickitat County, on the edge of the North Pacific Region, there were some large apple orchards planted on typical Palouse silt loam in the more humid portion of the region, and the trees grew well until they began to bear. Then it developed that the small supply of moisture, particularly in dry seasons, resulted in small fruit and low yields. There are no fruit farms reported in Adams County, and it is scarcely conceivable that there could be any on unirrigated Ritzville soils, because of the lack of sufficient moisture. The fruit farms average about 50 acres in area, of which about 20 acres are in crops, including the orchards, and 12 acres are in pasture. The average value of products per farm exceeded $2,000 in Spokane County in 1929, and was $3,000 in Walla Walla County and $4,000 in Whitman County.

Nearly half the dairy farms in the Washington portion of the region are in Spokane County (531 farms). The influence of the moister climate and large local market in promoting diversification is again evident. But there are a few dairy farms even in semi-arid Adams and Franklin Counties (about 20 in each). In the semi-arid Big Bend counties, dairy farms average 300 acres in area, of which only 40 acres are in crops, and nearly 200 acres in pasture; but in the moister counties to the east the dairy farms average only a little over 200 acres in size, of which 40 acres are in crops and 60 acres are in pasture. The other 100 acres are not accounted for by the Census, but doubtless include some fallow and waste land, as well as the farmstead. Total value of farm products averaged a little less than $3,000 per dairy farm in Spokane County, and somewhat less in the drier counties.

Part-time farms are surprisingly numerous, not only in the Columbia Plateau Region, but in most parts of the United States. Part-time farms, according to the Census, were those "where the operator spent 150 days or more off the farm, in other than farm work, or reported an occupation other than farmer, provided the value of products did not exceed $750." Nearly half of these farms in the Washington portion of the region were in Spokane County, and were mostly small home places of persons whose principal work was in the city. For the region as a whole these farms averaged nearly 60 acres of land per farm, but only 7 acres in crops. For Spokane County the average area was only 40 acres, but with 7 acres also in crops.

More than half of the self-sufficing farms, which are farms "where the value of farm products used by the operator's family was 50 per cent or more of the total value of all products

of the farm" are also in Spokane County. The self-sufficing farms average about 100 acres of land per farm (more in the semi-arid and less in the sub-humid sections), but only about 11 acres of crops. There were also about 50 acres of pasture per farm in the Big Bend counties and 20 acres in the moister eastern counties. These self-sufficing farms are mostly the homes of the humble, the value of products per farm averaging only about $300.

More than half the poultry farms are also located in Spokane County. These range in area from 40 acres per farm, in Spokane County, to over 100 acres in the Big Bend counties. But there were only about 10 acres of crops per farm in both sections. The value of the products was about $2,000 per farm in Spokane County, but was less in the Big Bend counties. From this sum, the cost of feed should be subtracted to obtain a net income, for doubtless most of the feed was purchased. Apparently the majority of these poultry farms are also homes of the humble.

The stock ranch, which was the original system of farming prior to the plowing of the land for wheat, affords a contrast to these almost suburban systems of farming just described. These stock ranches average over 4,000 acres in area, but with only a little over 100 acres in crops, nearly all the remainder being non-plowable pasture. There are only a few stock ranches in Spokane County (21). Most stock ranches are located where land is cheaper, that is, in the drier and the rougher areas. These stock ranches yield products exceeding in value even those of the cash-grain farms,—over $10,000 per ranch in Klickitat County, $6,000 in Grant County, where there are 85 such ranches, and nearly $20,000 per ranch in arid to semi-arid Franklin County. Little wonder that many stockmen look down upon the poultryman, and even the dairyman, with disdain.

FIGURE 349.—The portion of the Columbia Plateau Wheat Region receiving more than 18 inches of precipitation and adapted to the production of peas, sweet clover, or alfalfa in rotation with wheat, where soil and lay of land are suitable. Sweet clover doubtless can be grown successfully farther west than is shown on the map, and peas also in favorable seasons or on especially suitable soils. (Map from "Farming Systems for Eastern Washington and Northern Idaho," Bul. 173, Idaho Agricultural Experiment Station, also Bul. 244, Washington Agricultural Experiment Station, by Severance, Hunter, and Eke, 1930.)

Here in the Columbia Plateau there is illustrated perhaps as well as anywhere in the Nation the evolution of agriculture during the past century. First came the missionary and the fur trader, who broke the trail for the cattlemen, while the miners in the mountains and along the streams provided a small market for farm

products. The sturdy and reliant pioneers grazed their herds on the grasslands, and drove their cattle hundreds of miles to market. Then it was discovered, contrary to the opinion of many cattlemen, that wheat could be grown successfully in this region of low rainfall. The railroads came, providing cheap transportation, and the grasslands were transformed into grainlands, except where the climate proved too dry for the crop, or the slope too steep for the machinery that must be used. Hundreds of deserted homes and even many vacant schoolhouses mark the former margins of settlement,—where the cattlemen's warnings proved worth while. More recently, with the growth of the cities, especially Spokane, there has come the development of many dairy, poultry, part-time and self-sufficing farms, while irrigation, wherever water could be obtained, has made possible the development of over a thousand fruit farms and half a thousand truck farms.

What is the next stage? Will man's conquest of nature continue and dairying extend, with the development of some drought-enduring leguminous crop, over the semi-arid wheat fields, restoring their fertility? Or will the depletion of soil fertility by continuous grain culture ultimately justify the early cattlemen's opinion that most of the Plateau was a range country? Moreover, if the cities soon decline in population, as seems very likely in the absence of immigration from abroad, there may be a contracting market for the milk and the eggs and the fruit of the newer agriculture of the region, as well as for the wheat and beef of the older agriculture. Time alone can tell, but the next 50 years may see changes as great as those of the last half century.

LAND TENURE

The proportion of the farms operated by owners, part-owners, tenants, and managers varies geographically within the Columbia Plateau Wheat Region, and much more with the type of farm. Tenants constitute about one-fourth of all farmers in the semi-arid Oregon section of the region, but one-third in the semi-arid Big Bend section of Washington. In the more humid counties to the east, the proportion is intermediate. Part-owners (owner-operators who rent additional land—sometimes more than they own) constitute over a fourth of all farmers in the Big Bend section, but only a sixth in the more humid section to the east. Full ownership is, accordingly, low in the Big Bend section,—including only about 40 per cent of all farms—and high in the more humid sections—nearly 60 per cent. Normally a newly settled country has a low percentage of tenancy, also a country of small farms, and the percentage tends to increase as agriculture grows older or the farms become larger. These two forces appear to counteract to some extent in the Big Bend country, which is more recently settled than the moister section to the east, but in which the farms are larger, at least in area. The high percentage of part-owners indicates a struggle toward full ownership, and also a desire to utilize the large-scale machinery more efficiently. But it is to be feared that the low prices of wheat during the years since the Census was taken have thrown many of these part-owners, as well as many full owners whose farms were mortgaged, back into the tenant status.

From 40 to 60 per cent of the farms were mortgaged in 1930, varying with the county, but the ratio of debt to value of the property was fairly small, 30 to 40 per cent in most counties. However, the decrease in value of farm real estate has been rapid since 1930, and the ratio of debt to value has now increased probably 20 per cent. Net returns per farm averaged probably only one-tenth as much in 1931 as in 1927 or 1928, and were even less in 1932. Largely as a consequence, voluntary sales of farms were only half as numerous in 1932 as in 1927 or 1928, while sales because of delinquent taxes and foreclosure of mortgages were nearly half more numerous. It is the young and ambitious part-owners and the full owners under mortgage who are likely to suffer most in a period of depression.

The differences in tenure vary greatly with type of farm. Of the "cash-grain" farms, mostly wheat farms, about 40 per cent were operated by tenants in 1930, 30 per cent by part-owners and nearly 30 per cent by full owners, with one per cent operated by managers. The very high proportion of part-owner farms is doubtless owing largely to the desire of capable young farmers to enlarge their holdings in order to take advantage of the greater efficiency of the combine and other large-scale machinery. The proportion of the farms operated by tenants is much lower wherever the care of animals is involved.

About one-fifth of the dairy farms, less than one-sixth of the general farms and the stock ranches, and only about one poultry farm in twenty were operated by tenants. Successful livestock farming generally requires the eye of the owner. Very few fruit farms, likewise, are operated by tenants, for in the successful production of fruit both experience and an unusual degree of skill and care are required. Moreover, in fruit growing much longer continuity of effort is involved than in the production of small grains or other annual plants. To develop an orchard requires as many years as to develop a good herd of cattle, and the loss which an incompetent tenant could occasion might be equally great. Few self-sufficing farms are operated by tenants, but for a different reason, —there is not enough produced to divide with a landlord.

THE PEOPLE

The total population of the Columbia Plateau Wheat Region was about 375,000, in 1930. More than half of the people lived in rural territory. Of the 173,000 urban, 115,000 were in the city of Spokane. Nearly half of the rural population, 91,000 out of 202,000, were "rural non-farm," that is, lived in rural territory not on farms, mostly in villages and suburbs of less than 2,500 population. Farm population, therefore, constituted only 30 per cent of the total.

THE TREND IN POPULATION

The rural population decreased 9 per cent between 1920 and 1930, and doubtless the farm population even more, while the urban population increased 8 per cent. The total population of the region decreased slightly, a development characteristic of agricultural areas in most parts of the United States, but not of the rural non-farm nor of the urban areas. Spokane increased in population only about 7,000 during the decade (after making allowance for

Hillyard), or 7 per cent, which is about one-third as rapid as that of urban population in the nation as a whole. The farms of the region grew larger with the progress of mechanization (in some of the drier counties the average area per farm increased nearly 50 per cent between 1920 and 1930), the farm population grew smaller, also the village population in all likelihood, and as the city population was engaged largely in serving the farm and village population, manufacturing being only slightly developed, the growth of the cities was restrained also.

FIGURE 350.—A typical farm in the Palouse Country. (Photo by E. D. Strait, Courtesy of U. S. Bureau of Agricultural Economics.)

The prospect for future population growth in the Columbia Plateau Wheat Region is not bright. There are 20,000 more males than females in the region. Every county shows a deficit of women, and in most of the dry-farming counties there are 10 men over 25 years old to 7 women of the same age. Strange to say the disproportion exists even among the children, though to a much lesser degree. It seems inconceivable that girl babies are not counted as human beings, as often happens in China, nor that there should be a sex difference in migration of children under 5 years of age, consequently it appears that there is an anomaly in the sex ratio at birth. Migration of the women out of the region occurs early, however, as is shown by the rapid fall in ratio of females to males from 10 years of age onward. In almost every county of the region, except Spokane and a few other counties containing cities, the males outnumber the females in every 5-year age group from 10 years of age upward. Apparently, there is not enough work for the young women on the large farms, and doubtless some of them dislike the partial isolation. So they go to the cities, many of them migrating beyond the boundaries of the region apparently, for there are also a few more males than females in Spokane and Walla Walla, the only cities in the region exceeding 10,000 population. Clearly the Columbia Plateau is a man's country.

A second reason why the prospect for population growth is not bright is the low birth rate. Birth rates, as

given in the Census for rural and urban population, are not reliable because of the large number of children born to rural women in city hospitals. A better criterion of human fertility is the ratio of children under 5 years of age to women 15 to 45 (child bearing age). This ratio is surprisingly low in the rural counties —scarcely more than sufficient to maintain permanently a stationary population even were the sex ratio normal. In Spokane City, there were in 1930 only about two-thirds enough children to maintain a stationary population, and the ratio was even lower in Walla Walla. Since there were 18 per cent fewer children in 1930 in the region as a whole 0–5 years old than 5–9 years of age, and nearly 5 per cent fewer 5–9 than 10–14 years of age, it is clear that as the middle aged people grow old and die, and are replaced by a declining number of young people, the population of the region will decline, unless there is migration into it from other states or from foreign lands. But further mechanization in agriculture is likely to increase the size of the farms, and promote migration out of the region rather than into it, and if some of the dry-land grain lands revert to pasturage this process will be accelerated. Here in the Columbia Plateau region an economic and social situation has developed which seems very likely to develop soon in most of the grain-growing regions of the United States, unless the recent notable migration from city to farm should prove permanent. And this migration seems less likely to be permanent in small grain-growing regions than elsewhere, because of the great increase in efficiency that has been made possible by the use of the tractor and combine.

IMMIGRANTS

About two-thirds of the people in the Columbia Plateau Wheat Region, in 1930, were native-born white of native parentage, 12 per cent were native-born white of foreign parentage, 11 per cent were native-born white of mixed native and foreign parentage, 10 per cent were foreign-born white, and less than 2 per cent were negro and other non-white, mostly Japanese and native Indians. Nearly all the Japanese live in the cities and suburbs, the Indians mostly on reservations or nearby. Almost every nation in Europe and many nations elsewhere are represented among the immigrants. In Spokane County alone, there are nearly 4,000 from Canada, nine-tenths non-French, over 3,000 from Sweden, nearly 3,000 from Germany, nearly 2,500 from Great Britain, nearly 2,000 from Norway, and over 1,000 from Italy. Ireland, Denmark, and Russia have contributed over 500 each. In semi-arid Adams and Lincoln counties, Washington, where practically all the land is devoted to wheat farming, there are 1,000 people born in Russia and over 500 born in Germany. In Douglas County, there are 150 Germans and as many more Scandinavians. Former Germans and Canadians were numerous in Franklin, Garfield, Grant, and Klickitat counties. In Walla Walla and Whitman counties there were nearly 1,200 persons from Russia, over 700 from Canada, as many more from Germany, and 500 from the Scandinavian countries. These foreign-born citizens have contributed greatly to the development of the region. Not least among their contributions have been native born sons and daughters, who are about

twice as numerous as the foreign born. On the other hand, there are several counties in the region without a negro. Nearly two-thirds of the 1,000 negroes in the region live in Spokane. There are 136 negresses in Spokane 15 to 45 years of age, and 36 negro children under five, 42 five to nine years old, and 47 ten to fourteen years old. Here, as elsewhere in the United States, the negroes in the cities are tending to die out as rapidly as the whites.

EDUCATION

Although the farms are large and far apart and the road to school is often long, only in Spokane County, where the schools are convenient, and in two counties in Oregon, does the proportion of the children 7 to 13 years of age attending school fall below 97 per cent. In most counties the ratio exceeds 98 per cent. More remarkable, from 75 to 85 per cent of the children 16 and 17 years of age, varying with the county, are attending high school; while from a third to nearly a half (in Whitman County, where the State College is located) of the young people 18 to 20 years of age, inclusive, are in the last year of high school or attending college. There are nowhere else in the nation such high percentages of young people (18 to 20 years of age) in school, except in a few Mormon counties of Utah and southern Idaho, a few highly cultured districts in California, and a few counties in the Great Plains States, in which colleges are located. This ratio varying from 33 to 45 per cent may be compared with 25 per cent in Massachusetts, 20 per cent in New York, and 15 per cent in Georgia. It should be recalled that many, perhaps most, of these students must needs drive a number of miles to school or college daily.

As might be expected, illiteracy among the native white population, outside of Spokane, is practically non-existent. The lowest rate, 0.2 per cent, is in the semi-arid wheat counties, where the farms are the largest. Among the foreign-born whites, the percentage of illiterate ranges from less than one per cent to about 9 per cent, in Adams, Lincoln, and Walla Walla counties. This high rate is associated, apparently, with the Russian immigrants.

The State College of Washington is located in the region, at Pullman, and the University of Idaho, at Moscow, ten miles away. Students from southern Idaho pass through Pullman, if they come by rail (and travel several hundred miles through Oregon and Washington) to reach their State University at Moscow. The first has about 3,000 and the second about 2,000 students. Gonzaga College (Catholic), at Spokane, has about 500 students, and Whitman College (Congregationalist), at Walla Walla, also has about 500 students. In addition, a large number of students from the region attend the University of Washington, at Seattle; or the University of Oregon, at Eugene; or the Agricultural College, at Corvallis; while a few go to the University of California and to eastern institutions.

RELIGION

About 104,000 people in the Columbia Plateau Wheat Region were members of a church in 1926, which is 28 per cent of the total population, or 36 per cent of the population over 14 years of age. About 30,000, or nearly 30 per cent of the church members, were Catholics, but judging by the figures for Spokane fully a fourth of these were under 13 years of

age. In the city of Spokane the 38,000 church members constituted 34 per cent of the total population, clearly a much higher proportion than in the rural districts. The Methodists are the leading Protestant denomination, with a membership of 15,000, or half that of the Catholics. The Disciples of Christ rank next, with nearly 9,500 members, followed by the Presbyterians, with 8,600 members. The Lutherans are almost as numerous, while the Baptist and Congregationalist churches each have about 6,000 members. The Protestant Episcopal church numbers about 5,000 communicants, and there are nearly 1,000 Adventists in Walla Walla County, with over 500 more in Spokane. There are also in Spokane 1,000 Latter Day Saints (Mormons), 500 members of the Church of Christ, Scientist, and 1,350 members of Jewish congregations.

It was a missionary, Rev. Whitman, who first brought the agricultural possibilities of this region to the attention of people in the East; and when one recalls the privations and the loneliness that the pioneers endured, particularly the women (and which many farm families are enduring even at the present time), the importance of religion in affording consolation and comfort during the development of the region must not be underestimated. Without doubt, also, the desire to leave a heritage to their children gave strength and courage to the pioneers and their successors, who have built up within the brief span of less than a century a civilization perhaps as high as the world has ever known.

The permanency of this great achievement now appears to be endangered by the decline in population, already well started. Progress in technique has induced migration from the farms and depleted the farm population of many of its young people—potential parents; while the rapidly declining birthrate has now fallen far below the reproduction level in the cities. Even should the recent migration from cities to farms (noticeable in the environs of Spokane) prove permanent, it is not certain that the downward trend in number of births would be reversed. The dissemination of urban attitudes and ambitions among the rural people may be facilitated by the farmward migration of city people, and induce a decline in the birth rate in country districts as rapid as in the cities. Perhaps before the decline becomes too precipitate to be reversed there may develop a greater willingness to sacrifice for the sake of children and the future, such as characterized the pioneer settlers in this region.

NOTE.—Acknowledgment is due Mr. Byron Hunter, of the Bureau of Agricultural Economics, for valuable criticism.

IRRIGATION IN SOUTH AMERICA

Dorothy Sisson and R. H. Whitbeck[1]

SOUTH AMERICA is officially reported to have between six million and seven million acres of land under irrigation. By way of contrast, it may be stated that the United States has somewhat over twenty million acres under irrigation.

TABLE I

ACREAGE OF IRRIGATED LAND IN SOUTH AMERICA *

Country	*Approximate Acres Irrigated*
Argentina	3,000,000
Bolivia	1,000
Brazil	1,000
British Guiana	100,000
Chile	2,458,000
Colombia	51,000
Dutch Guiana	1,000
Ecuador	1,000
Peru	1,000,000
Venezuela	1,000
Total	6,614,000

* From U. S. Trade Promotion Series No. 73, p. 32, 1929.

IRRIGATION IN COLOMBIA

The Republic of Colombia has only one irrigated region of importance, the Santa Marta district. Irrigation works are proposed elsewhere, and a few small projects, installed and operated on a coöperative basis by farmers owning adjacent lands, are to be found.

The Santa Marta district on the north coast consists of a rich valley extending south from Santa Marta to Fundación, the present railroad terminus. On the piedmont plain that spreads out for several miles from the base of the mountains flow a number of streams that have built up plains of loam soils ideal for bananas when well drained. There are approximately 51,000 acres of banana plantations situated along the forty-eight mile stretch of railroad from Ciénaga to Fundación. With the exception of one thousand acres irrigated by pumping from the small streams, the remainder is gravity irrigation. It is not necessary to irrigate at all seasons as there is considerable rainfall. During the dry season from November to April, the plantations are watered about every twenty days.

All of the irrigation projects are under private ownership. The only control exercised by the government is in giving permission to use public water for irrigation purposes. Approximately one-half of the 51,000 acres is owned by the United Fruit Company, the other is in the hands of private planters. The United Fruit Company buys the fruit from the planters, transports it to the dock at Santa Marta, and ships it in their own boats to Europe or the United States. The price per acre of a plantation bearing fruit is about four hundred dollars. A minimum production of two hundred eighty bunches per acre per year is calculated.

VENEZUELA

There are no official statistics showing the acreage irrigated or the amount invested in such projects in Venezuela. In the Caracas Valley irrigation ditches have been in existence since the period of the Conquest, and this valley is still irrigated in several places. In the plateau region of northern Venezuela are regions of

[1]The manuscript of this paper, like most of those received, is well documented, but because of the cost, ECONOMIC GEOGRAPHY deletes practically all footnotes, except those that seem unavoidably impossible of cutting out.—EDITOR.

irrigated crops and dry pastures producing the greater part of what the owners consume, but little else. Due to the rough topography and insufficient precipitation the region has only a few thousand acres of crop land. The great handicap to crop production is the small amount of water available and the erratic rainfall. The total area of systematically irrigated land in Venezuela is roughly estimated at 1,000 acres.

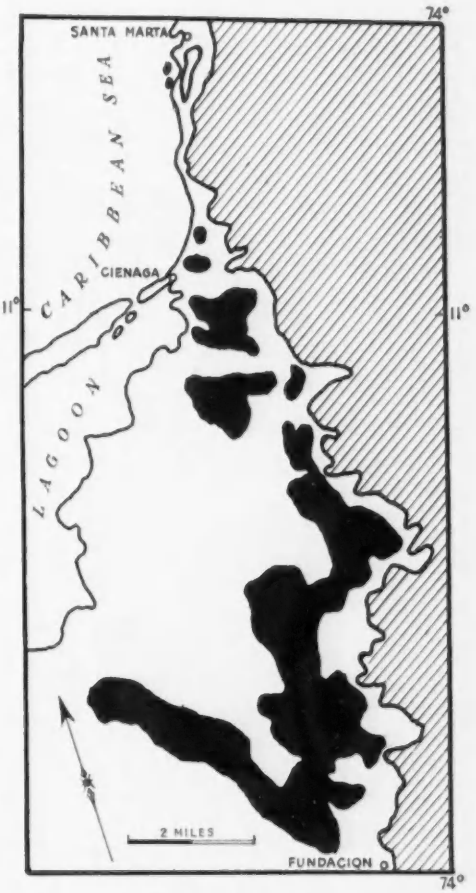

FIGURE 1.—Irrigated lands (black) south of Santa Marta, Colombia, devoted to bananas. (Map generalized from Fig. 254 in C. F. Jones' "South America." Cross-lined area, mountains.)

ECUADOR

Irrigation on a small scale has been carried on in Ecuador since colonial times. The systems take water by gravity from the mountain streams and are privately owned. It is estimated that in the Sierra region about one thousand acres of Temperate-zone crops are irrigated. In the irrigation of these crops a canal taps a mountain stream and the water is conducted to its destination by means of ditches and earth embankments. When aqueducts are needed they are built of hollowed logs or simple wooden structures. Thus, water is carried for considerable distances around hillsides and occasionally through tunnels to shorten the distance. There are a few other minor regions of small-scale irrigation in Ecuador but they are of only local importance.

BOLIVIA

Crude irrigation has been practiced since very early times in the plateau of Bolivia. Shut off by topographic and climatic barriers from neighboring peoples, the inhabitants have had to provide their own livelihood. To produce food, irrigation was frequently necessary. In the Central Andean Crops and Grazing Region, extending from two degrees north latitude to twenty-four degrees south latitude, many of the cultivated areas and pasture lands are irrigated. The Indians divert water from the streams high up the mountains and direct it around slopes and across ravines to the fields below. South of 17 degrees south latitude irrigation becomes even more necessary. The valleys are characterized by a relatively intense form of agriculture. The crops grown are maize, wheat, barley, alfalfa, and fruit. Small-scale irrigation is widely practiced but the acreage is unknown. The irrigated land in the Cocha-

bamba Basin is mostly in maize, the best crops coming from the fields watered by silt-laden streams. Here the grain yields as much as two hundred fold compared with the forty-fold return on unirrigated land. Most of the unirrigated fields produce wheat and barley. However, it is probable that not more than ten or twelve per cent of the cultivable area of these valleys is under irrigation.

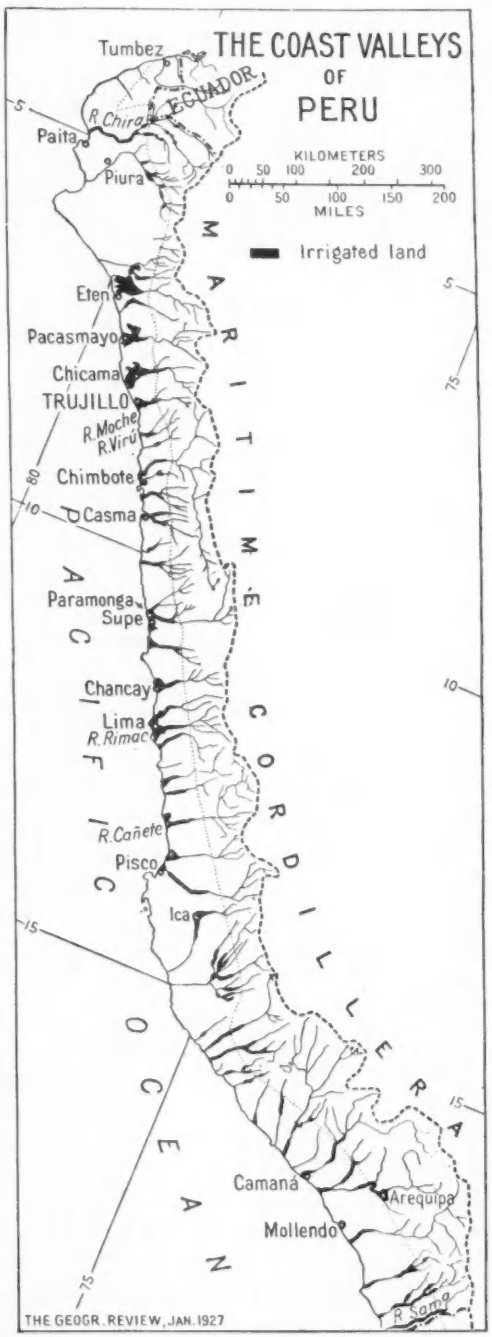

FIGURE 2.—Irrigated valleys (black) along the coast of Peru. (Courtesy of the *Geographical Review*, published by the American Geographical Society of New York, Vol. 17, p. 39, 1927.)

In the southern Puna where water is more abundant, especially in the spring-fed dales at the heads of valleys, some hundreds of acres of irrigated land may be found. The total area under irrigation in Bolivia is not even approximately known, but it would seem to reach several thousand acres, rather than the 1,000 acres given in Table I.

PERU

For the purpose of this discussion, Peru may be divided by the main crest of the Andes into two sections; the eastern, sloping to the Amazon Basin, and the western, extending to the Pacific Ocean. It is in this western part that the rivers supplying irrigation waters have their watersheds and courses. The coast lands consist of a series of plains, in some places reaching a maximum width of about eighty miles. Throughout this coastal strip rivers are numerous, some fifty or more descending from the western slopes of the Andes. They vary greatly in volume and general economic importance. Those having their sources in the mountains within the zone of regular rainfall are perennial, although they shrink during the dry season to mere brooks and about one-half of them do not reach the sea. During high water they have great erosive powers and as their speed is checked in flowing across the plain, they deposit

their loads in the form of alluvial fans and flood plains. Precipitation along the coast is very slight indeed. At Lima, eight miles inland, it varies from two to four inches, most of this being in the form of heavy mists.

AGRICULTURE ON THE COAST LANDS

Agriculture in Peru is most important in the dry, relatively narrow coastal lowlands and adjacent river valleys. Many of the irrigation systems employed in these valleys were established by the ancient Incas, and are still efficient. The soils are deep and are high in mineral food though lacking in humus. With irrigation and fertilization they produce large crops, especially of sugar cane and cotton, the two great commercial crops of the coast lands. Many subsistence crops are grown including rice, corn, legumes, wheat, barley, and alfalfa. It has been estimated that there are approximately one million acres of land included in these irrigation projects, although all of this land is not actually reached by the ditches. Cotton is more widely distributed than sugar cane since its production requires less capital. It is grown on a commercial scale in thirty-five valleys, not only on the large estates but on small holdings devoted exclusively to growing cotton. During the past forty years

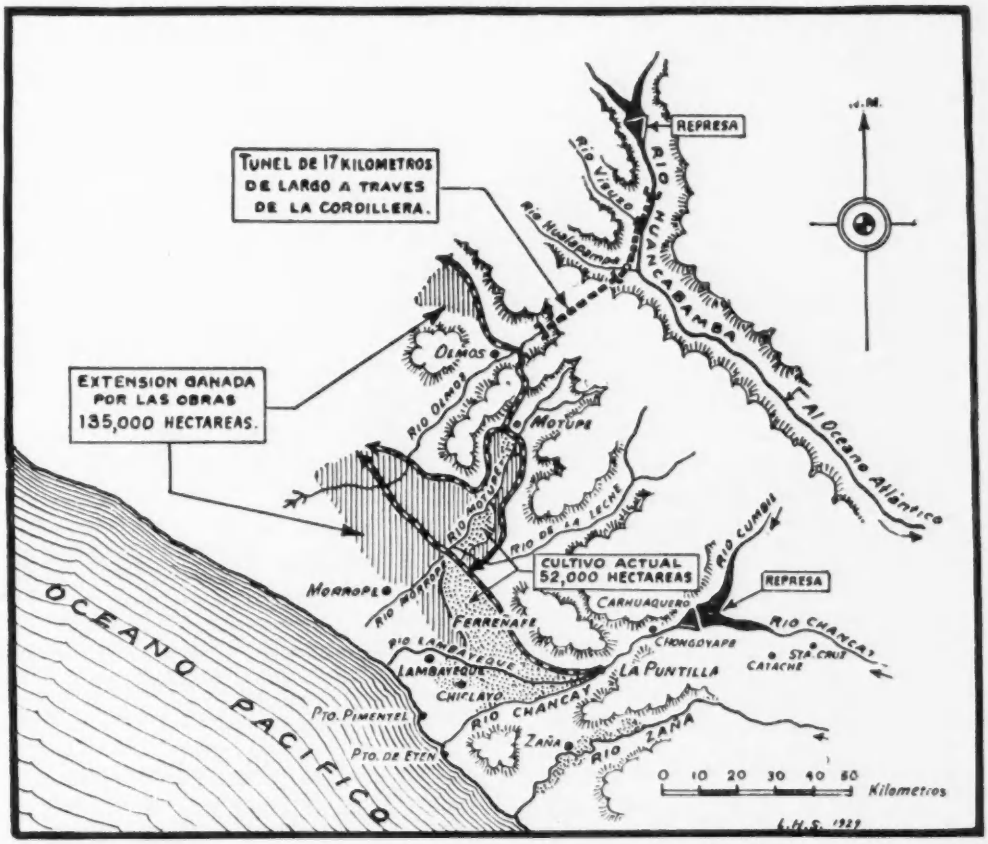

FIGURE 3.—Irrigation of the Olmos (Lambayeque) Region on the coast of Peru. (From Anales del Primer Congreso de Irrigación y Colonización del Norte, Vol. 1, p. 21, 1929.)

sugar has risen from insignificance to one of the leading money crops of Peru. Production is confined to about fifteen valleys.

IRRIGATION METHODS AND PROJECTS

The irrigation facilities of the coast have been limited chiefly to gravity canals and distribution ditches, supplemented in a few valleys by pumping plants. With few exceptions the rivers carry sufficient water for irrigation purposes only from November to April. During the past twenty years the government has shown increasing interest in irrigation and has planned a series of projects for various sections of the coast; the first (17,000 acres), in the Cañte Valley, was completed in 1923. Work was started early in 1924 on the next project, in the Olmos section of the Department of Lambayeque. This involves the diversion of the waters of the Huancabamba River to the coast by means of a tunnel through the mountains. It will reclaim by irrigation between 150,000 and 200,000 acres of land at an estimated cost of approximately $20,000,000.

Crops in the Piura district proper are grown entirely by irrigation. The Piura River dries up completely from about August to December, while the Chira is permanent. Since the channel of the Chira River runs considerably below the surface of the land, the use of pumps is common. The main irrigation canal in this valley is administered by the Peruvian Corporation. The existing canals are inadequate for the cultivated areas. Cotton is the chief crop of the Piura-Chira district. Rice is grown, though the supply is insufficient for local consumption.

The total area of land under irrigation in the three valleys of the Trujillo district is estimated at about 123,500 acres, of which 86,485 acres are in the Chicama River Valley, 24,710 acres in the Moche Valley, and 12,355 acres in the Viru Valley. It is estimated that the acreage under cultivation could be doubled if sufficient water were available. The

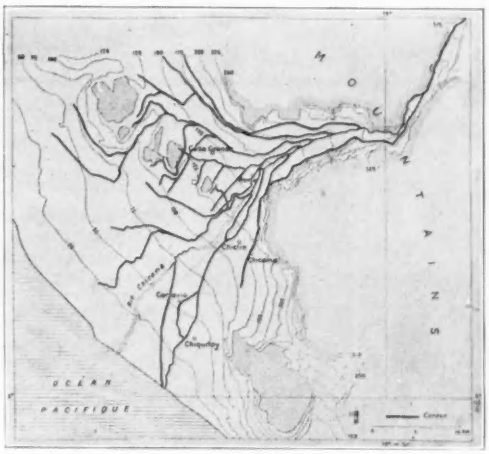

FIGURE 4.—Type of irrigated fan at the mouth of a mountain valley (Chicama) along the coast of Peru. Main canals are shown by heavy lines; contours by light lines. (From *Geographie Universelle*, Part II, Amerique du Sud, Tome XV, p. 303, Paris, 1927.)

irrigation works are the usual gravity canals and tributary ditches that serve the haciendas of the coastal section. The sugar industry overshadows all others in the Trujillo district, particularly in the Chicama and Moche River valleys which are given over mainly to the production of sugar cane and produce almost one-half of the total crop of Peru. Of the five large plantations four are in the Chicama Valley. The total area devoted to sugar cane is estimated at about 50,000 acres. Experience in Peru has proven that the sugar industry is profitable only when conducted on a large scale. Modern agricultural machinery of all types is extensively used, and the sugar mills are equipped with efficient machinery.

The average production of cane varies from forty to sixty tons per acre.

The agricultural lands of the Lima-Callao district are found in valleys of three rivers, including the Rimac. The total area under cultivation is estimated at 90,000 acres. Lima is located near the mouth of the Rimac Valley eight miles from the coast. Sugar is the chief crop, but in the vicinity of Lima cotton competes with sugar.

The new Cañete Valley project involves the diversion of a portion of the Cañete River by means of a canal tunneled through the mountains and leading to the pampas. A concrete dam has been built, equipped with six intake sluices and five drainage sluices. The water is carried to the coast by a main canal, passing through ten tunnels, the longest of which is 2,322 meters in length. This modern irrigation project, the first of its kind in Peru, was planned and constructed by Charles W. Sutton, an American hydraulic engineer. Cotton is by far the most important industry in this valley, though there is some sugar production. The area under cultivation in the Pisco Valley is approximately 25,000 acres. The arable lands begin at the coast and extend at intervals along both sides of the river for some forty-five miles. The Pisco River is one of the most important in the coastal zone.

The arable lands of the Ica Valley begin some twenty miles north and end about the same distance south of the town of Ica. The total area under cultivation in this stretch of forty miles is under 50,000 acres. Irrigation facilities consist of seven gravity canals. Lack of water seriously handicaps cultivation and a complicated new project has long been under consideration.

Irrigation is relatively more important to Peru than to any other South American country. Over half of the agricultural capital of Peru is invested in irrigated farms, and about half of the agricultural income is derived from them. Half of the national income is derived from activities dependent upon irrigation. The only important agricultural exports are sugar and cotton, both grown almost exclusively under irrigation.

CHILE

Irrigation was introduced into certain of the northern and central valleys of Chile by the Indians and reached considerable development.

NORTHERN CHILE

During the colonial period and during the republic the irrigated area has been gradually extended. By 1921 the following canals were completed: the Mauco Canal, drawing water from Aconcagua River, has a main length of forty-five miles and irrigates 8,000 acres. The Maule Canal, diverting water from the river of the same name, is one hundred fifteen miles long and supplies 113,000 acres of land. The Laja Canal diverts water from the Laja River: the main canal is twenty-five miles in length with distribution canals amounting to two hundred forty miles. This project is calculated to serve 110,000 acres. Another canal recently completed is the Melado supplying water to 75,000 acres in the Province of Lenares. This project presented very difficult engineering problems, including the Melado tunnel two and one-half miles in length, "the greatest of the kind on the continent." At present it is estimated that about 2,450,000

acres are irrigated by public and private projects, making Chile second only to Argentina in irrigated acreage. The following table gives by Provinces the acres irrigated and those deemed possible of future irrigation.

TABLE II

IRRIGATION IN CHILE BY PROVINCES *

Province	*Acres Irrigated* †	*Acres Capable of Irrigation*
Tacna	15,263	4,289
Tarapacá	4,372	10,494
Antofagasta	.....	.....
Atacama	43,800	90,312
Coquimbo	138,734	187,163
Aconcagua	90,747	99,589
Valparaiso	77,490	91,565
Santiago	293,200	205,839
O'Higgins	312,343	50,140
Colchagua	343,412	175,876
Curico	166,778	164,128
Talca	196,793	217,739
Linares	227,611	298,252
Maule	48,558	81,512
Nuble	232,158	498,600
Concepción	45,820	303,263
Arauco	17,268	176,133
Bio Bio	61,542	263,087
Malleco	52,768	185,083
Cautín	22,746	179,854
Valdivia	36,484	585,056
Llanquihue	14,492	171,720
Chiloé	2,669	50,737
Territory of Magellanes	34	.....
Total	2,446,083	4,090,431

* From U. S. Trade Promotion Series No. 73, p. 38, 1929.
† Land included in irrigation projects, but not all actually irrigated.

The irrigated regions of Chile fall into two classes: (1) the few valleys of the North lying between 18 and 30 degrees south latitude, which may be called oases in the desert, and (2) the choice section from 30 to 38 degrees south latitude, often called Middle Chile.

Irrigation was practiced in the valleys of the North before the Spanish occupation. The northern valleys stand out in contrast to the dull landscape—ribbons of green in a barren land. The important port of Arica is situated at the mouth of one of these valleys. From Arica in the extreme north to the mouth of the Copiapó River there is a stretch of six hundred miles of coast line in which only one river reaches the ocean throughout the year. In the province of Antofagasta the river Loa describes a huge S from the mountains to the sea. Practically all of the permanent population of the Loa Basin are grouped in six agricultural communities. Alfalfa is grown, and is sold to the cattle drivers that pass through. Fruits are produced in quantities and are sold to the distant nitrate establishments.

In the province of Atacama lies the valley of Copiapó, once famous for copper and silver. It is about twenty-seven miles from the coast, and is some twenty-seven miles in length and three miles wide. The valley abounds in fruit trees, vineyards, and grain fields.

MIDDLE CHILE

Middle Chile extends from Coquimbo, about 30 degrees south latitude, to Concepción, 38 degrees south. The region has a Mediterranean climate with its winter rains and summer droughts. The precipitation varies from thirty inches a year on the southern margin to less than ten inches on the northern. Since the heavy precipitation in the Andes comes in the winter (April to September), it is in the form of snow and is thus conserved for the growing of crops in the valley during the summer.

The Mediterranean Crop Region, though small, is by far the most important agricultural region of Chile. It has nearly two-thirds of the cultivated land in Chile, ninety-five per cent of the vineyard acreage, and eighty-five per cent of the alfalfa acreage, as well as practically all of the corn and barley. However, only about twelve per cent of the area is in crops and nearly three-fourths of

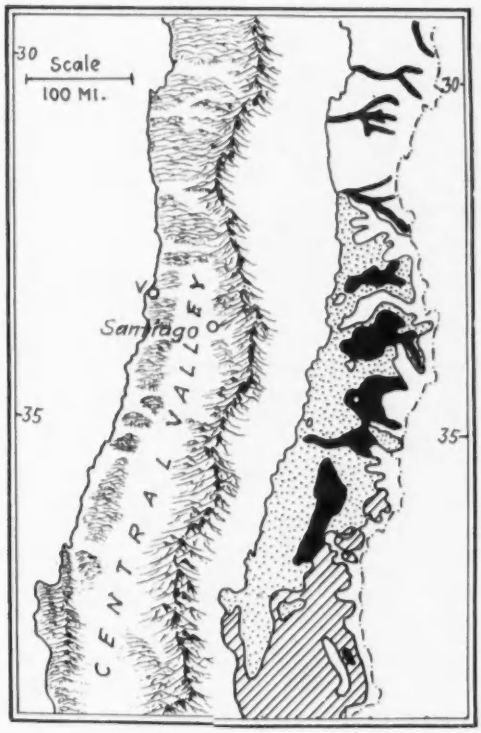

FIGURE 5.—Central Valley of Chile. Black, irrigated land; stippled, unirrigated farm land; cross-lined, forests. (Right hand drawing from Mark Jefferson's map in "The Rainfall of Chile," American Geographical Society Research Series, No. 7, 1921.)

the area is in pasture. Here, as in all parts of Chile, large land holdings prevail. Except in small irrigated valleys near Santiago and in the south where there are German and Dutch settlements, some 1,512 owners control three-fourths of the farm land of Chile. Vast haciendas, some of which include entire coastal valleys and adjacent hill lands lead to extensive agriculture.

The Central Valley is the most densely settled and richest agricultural region on the entire west coast of South America. The level-to-rolling surface is broken in places by low transverse hills and by major streams that cross the valley from the Andes and enter the sea through breaks in the coast ranges. This section contains ninety per cent of all the irrigated land in Chile. The conditions for irrigation are almost ideal for it is easy to direct the water from the sediment-laden streams, rising in the high mountains, across the sloping alluvial plains. Bordering the canals are lines of weeping willows and Lombardy poplars, dividing the farms like checkerboards. The great Maipo Canal has been in operation for centuries.

Until recently the irrigation systems were maintained on individual haciendas by associations of landowners. The government is now increasing the crop land. Near Santiago an extensive project irrigating 62,000 acres has been completed. Another canal tapping the Maule River extends irrigation over 115,000 acres. From the Laja River newly constructed canals irrigated 110,000 acres.

The Central Valley, having a large extent of alluvial plains, easily irrigated, represents the most intensive use of the land in Chile. "Considering the three departments, Maipo, Loncomilla, and Bulnes, which are representative areas in the Central Valley, approximately ninety-three per cent of the total area in these departments is in private land holdings of which 30 per cent is irrigated. Sixteen per cent of the area in land holdings is in crops, 55 per cent in pasture, and 20 per cent in woods and forest."

ARGENTINA

The most successful irrigation projects in Argentina have been those constructed and administered by the National Government. There are, however, enterprises conducted by the provincial governments and by private initiative. Prior to 1909

irrigation was in the hands of the provincial governments and relatively little was accomplished. Since the passing of the national law for placing the work under the supervision of the National Department of Public Works more projects have been undertaken and completed. Most of the successful coöperative projects have been turned over to the government. The majority of the systems have gravity distribution. About 14,820 acres are served by water that is pumped from the rivers by the centrifugal type of pump. In only a few cases are wells used. In the Territory of Neuquen about 7,410 acres are irrigated by pumping plants on the Limay River. At present the total area irrigated in Argentina is about 3,000,000 acres. The following table shows the approximate acreage under irrigation in the various provinces.

TABLE III

IRRIGATED LANDS IN ARGENTINA *

Province	*Acres Irrigated*
Mendoza	1,482,600
San Juán	494,200
San Luis	161,615
Córdoba	593,040
Santiago del Estero	172,970
Tucumán	296,520
Catamarca	74,130
La Rioja	37,065
Salta	123,550
Jujuy	98,840
Neuquen	14,826
Rio Negro	71,659
Chubut	24,710

* From The Times Book of Argentina, *London Times*, 1927.

Work in progress will add 88,956 acres.

There are many gradations in the irrigated lands of Argentina extending as they do from the irrigated vegas of the Patagonian Andes through the great oases of Mendoza and Tucumán to the fertile valley of Jujuy. The irrigation works over this large area may be classified as follows: (1) In the northwest and in the scattered provinces lying at the base of the Andes there are minor isolated oases, irrigated by diverting water from the mountain streams; (2) in the larger oases, especially Tucumán and Mendoza, where the streams are larger and more numerous, the irrigated area is larger, though the projects are still under the control of individual owners or companies; and (3) the government projects such as those in the valley of the Rio Neuquen in Patagonia.

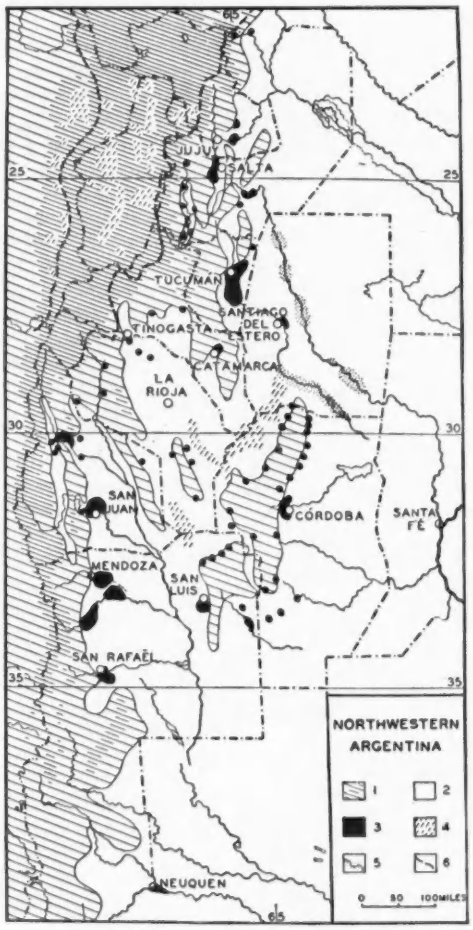

FIGURE 6.—Irrigated lands of Argentina. (1) Mountain areas, the close ruled are above 10,000 feet elevation, (2) plains of northwest Argentina, (3) the oases, (4) salars, (5) banados, (6) east and west borders of Puna de Atacama. (From "South America" (Fig. 145) by the courtesy of C. F. Jones and Henry Holt & Company.)

THE NORTHWESTERN OASES

The oasis of Jujuy is a cresent-shaped area along the Rio Jujuy in the southern part of the province of the same name, and lies two hundred miles north of Tucumán. This new sugar region has developed on the deep, rich, alluvial soils favored by much sunshine and high temperatures. Though irrigation is more necessary here, there is little danger from frost. Each estate is a large clearing in the forest. The oasis of Jujuy ranks next to Tucumán in sugar production; the amount is about 70,000 tons per year.

Another sugar district has recently developed in the piedmont area in the intermontane basin of Salta. The agricultural conditions are similar to those of Jujuy. The restricted amount of arable land, remoteness of location, and sparsity of population cause the area to suffer in competitive sugar trade.

In the provinces of Catamarca, La Rioja, and Córdoba there are a number of small irrigated oases. The chief money crops are wine and alfalfa, and the trade is with the miners or with the herders of the cattle being driven over the mountains. Each produces a variety of subsistence crops such as vegetables and fruits.

The oasis of Córdoba lies farther to the east than the others, on the margin of the pampas. Here is one of the greatest irrigation projects of Argentina, collecting water from the Rio Primero and transforming desert wastes into gardens.

The Larger Oases of Argentina

Tucumán lies in the southeastern part of Tucumán Province at the western edge of the Chaco Monte country. Before the development of the sugar industry, the area was chiefly pastoral. However, sugar cane was of early importance. The first grinding mill was set up about the middle of the eighteenth century by a group of Jesuit priests.

The sugar district is comparatively small and it is not, properly speaking, an oasis, but rather a moist area in the heart of a less-favored region. The area is about fifty-five miles long and one hundred miles wide; Tucumán, near the center, receives twenty-eight inches of rain, with a marked summer maximum. Since water is available and its use gives better results in cane culture, irrigation is the rule. The water supply is furnished by a number of evenly-flowing streams descending the eastern flanks of Aconcagua and spreading out over the alluvial plain. The sub-tropical climate, fertile soils, and abundant water adapt this area to a variety of crops. However, sugar cane occupies one-half of the cultivated area of 350,000 acres and supplies some 80 per cent of Argentina's crop.

TABLE IV

SUGAR PRODUCTION IN TONS

Province	*1930*	*1928*	*1927*
Tucumán	276,000	274,442	325,519
Salta	34,000	31,711	25,369
Jujuy	63,000	56,773	61,115
All Others	8,000	12,403	9,598
Total	381,000	375,329	421,601

The oases of Mendoza, San Rafael, and San Juán offer a decided contrast to Tucumán, for they represent an entirely artificial development in the midst of a desert environment. They are, however, on a main route of travel and were settled by Indians from Peru and Chile long before the coming of the Spanish. The large-scale production of grapes

in Argentina is limited to the oases of Mendoza, San Rafael, and San Juán. Water is derived from the streams rising in the high Andes. All of the streams are subject to flood when the rapidly melting snows of the mountains create rushing torrents at the beginning of summer. The climate is extremely favorable for viticulture. The vineyards are situated on the sloping fans where the streams debouch from the Cordillera; at Mendoza there is an additional strip over the fans, and great quantities of water are wasted.

These oases have eighty-two per cent of the grape acreage of Argentina, Mendoza having 170,000 acres, San Juán 100,000 acres, and San Rafael 35,000 acres. The bulk of the crop is used for wine. The land holdings are chiefly in large estates with immigrant colonists or native labor tending a portion of the vineyard or working as contract labor at a specified price. The oases have

FIGURE 7.—Irrigation dam on the Mendoza River in western Argentina.

some sixty miles in length along the Tunauyan River. This was the line of traffic in the colonization of the area. On the fans the distribution of water to large areas is easy. The soil is a light, fine, silt loam. The water rights of these oases are not independently owned. Concessions are assigned according to the area cultivated. There is much to be done to the various existing irrigation systems to make them thoroughly efficient. They are merely intakes at various points along the rivers with canals conducting the water other important products as well. In Mendoza the alfalfa area surpasses that of vineyards. Of the cultivated land forty-six per cent is in alfalfa and twenty-eight per cent in vineyards; corn ranks third in acreage, followed by potatoes and fruits. San Rafael produces a large part of the alfalfa seed for home use and for export. Some of the wineries are very large; one has an annual capacity of more than 6,000,000 gallons. The annual production of wine in the irrigated lands of Argentina exceeds 200,000,000 gallons. The to-

tal production is distributed as follows:

Province	*Gallons*
Mendoza	150,000,000
San Juán	45,000,000
All Others	6,500,000
Total	201,500,000

Rio Negro Oasis

Near the junction of Rio Limay and Rio Neuquen, forming the Rio Negro in Patagonia, is a sixty-mile strip forming a narrow, partially irrigated oasis. The land is parcelled out by the government, two hundred fifty acres to an individual. Several areas are suitable for irrigation but the cost of the projects is rather high.

BRAZIL

A region of erratic rainfall exists in northeastern Brazil in the plateau back of the coast range, not far from the equator. The largest dry areas lie in the four states: Parahyba, Rio Grande do Norte, Piauhy, and Ceara. The area suffers not so much from insufficient rainfall as from its exceedingly uncertain nature. In some years there is a succession of downpours accompanied by disastrous floods; in other years the rain fails entirely. The largest dry areas, those with less than sixteen inches of rainfall, lie in the São Francisco River Valley. Some irrigation had been undertaken in this region previous to the inauguration in 1919 of President Pessoa, a native of Parahyba; but during his administration plans were perfected embracing expensive irrigation works in all of the Northeast. The plans originally drawn up contemplated ten large masonry dams, six of which would have irrigation basins, and numerous smaller dams and wells.

The enormous scale of these plans called for so much money that vigorous complaints arose from other parts of Brazil, and a government commission recommended that careful study should precede any further expenditures. In 1915 a public decree ordered all public works stopped. Only one large dam has been finished and this is not used for irrigation but for supplying water to the city of Fortaleza. A large number of inexpensive earth dams have been built and a number of irrigation wells have been sunk.

FIGURE 8.—The San Roque Dam at Córdoba, Argentina. (Photo from Ewing Galloway, N. Y.)

In spite of the size of the projects and the early activity, little has actually been achieved and the present area under irrigation is small, probably not over a thousand acres, and all the land that it is possible to irrigate under existing conditions is not being utilized.

BRITISH GUIANA

Along the coast of British Guiana about 140,000 acres of land are devoted to crops, 90,000 acres of which are given to sugar cane and rice. Most of this land is low, even below the sea level at high tide, and is protected by dikes and traversed

by canals which sometimes act as drainage ditches and at other times as irrigation canals. Rainfall is usually ample but serious droughts occur, and at such times irrigation is necessary for all crops. Of course, the rice crop must be flooded in its early stages. Only in these ways is irrigation practiced in British Guiana.

BOOK REVIEWS

UNITED STATES DEPARTMENT OF COMMERCE

BUREAU OF FOREIGN AND DOMESTIC COMMERCE

Foreign Trade of the United States in the Calendar Year 1931. By Grace E. Witherow. Trade Information Bulletin No. 808. Price, 10 cents.

Although foreign trade dropped considerably in both volume and value during 1931, the United States maintained its position as the world's leading export nation and ranked in the usual order, next to the United Kingdom in value of imports. The marked decline in dollar value was attributable in large part to the sharp decrease in prices which affected all classes of commodities. In physical volume, exports show a decline of 20 per cent, while the reduction in imports was 10 per cent.

The Leather Trade of the United Kingdom. With notes on the General European Leather Situation. By American Trade Commissioner Walter B. Hertz. Trade Information Bulletin No. 811. Price, 5 cents.

The United Kingdom is the largest foreign purchaser of American leather. Our sales to that market in 1932 were valued at $2,831,124, representing a greater value than our shipments to the three next leading countries and constituting 21½ per cent of our total leather export trade that year. British leather exporters have become increasingly active in the American market and now supply to the United States more leather than any other foreign country except Germany.

Manufacturing Market Statistics. By Charles B. Eliot. Domestic Commerce Series No. 67. 1069 pages. Price, $1.00.

It is believed that this bulletin constitutes a first step forward in the assembling of data which can be used for analyses in that area of marketing represented by sales to industries.

Every manufacturer or distributor is faced with the problem of locating his markets and promoting his sales with a minimum of expense. Increasing competition and decreasing margins demand the greatest degree of efficiency in every phase of manufacture and distribution if profits are to be realized. It becomes more and more imperative to answer the questions of location of the market, its demand, and its capacity of consumption.

Aids to Retail Grocery Profits. Practical Hints Designed to Help Make More Money for the Grocery Retailer. Domestic Commerce Series No. 71. Price, 10 cents.

The plans for improved grocery-store operation described in this book came out of the actual experience of grocery stores. Greater profits for the grocers and greater benefits to consumers through improved service and more economical operation have resulted from the use of these plans. The investigation at Louisville, Kentucky, which developed the facts was conducted under the supervision of the grocery interests of the country, through their various local and national associations. The survey findings have been fully analyzed and presented in a series of detailed research reports.

Merchandising Requirements of the Drug Store Package. By Wroe Alderson and B. B. Aiken. Domestic Commerce Series No. 73. Price, 5 cents.

The National Drug Store Survey attempted to examine problems of merchandising affecting the drug trade, particularly the retail field, over a wide range of subjects. This study of the merchandising requirements of the drug-store package falls within the scope of this survey because of the current discussion of repackaging as one of the means of sales promotion.

Furniture Distribution in the Midwest. By Clarence R. Niklason. Domestic Commerce Series No. 75. Price, 10 cents.

This report is an analysis of various factors affecting production and distribution of furniture in the Midwest. It covers the states of Iowa, Wisconsin, Illinois, Indiana, Michigan, Ohio, and Kentucky.

Profits from Cost Analysis in Paint Distribution. By S. L. Kedzierski. Domestic Commerce Series No. 79. Price, 5 cents.

Handbook of Foreign Tariffs and Import Regulations on Agricultural Products. V. Grains and Grain Products in Europe and Other Major Markets. By Roberta P. Wakefield. Trade Promotion Series No. 31. Price, 50 cents.

Grains and grain products have for years been among the leading staple exports of the United States. Even with the rise in importance of machinery, petroleum products, and automobiles, wheat and wheat flour still ranked fifth in value among the leading commodities exported from the United States during 1930.

This present study covers the tariffs and the other official conditions affecting the importation of grains and grain products into the principal markets abroad and also the trade-control measures of the grain-surplus countries of Europe.

International Trade In Machinery Belting. By E. G. Holt and R. H. Sanger. Trade Information Bulletin No. 135. Price, 10 cents.

The United States now supplies nearly one-quarter of the total world exports of machinery belting, its share having decreased steadily since 1921.

The Silver Market. By Herbert M. Bratter. Trade Promotion Series No. 139. Price, 10 cents.

Among the features of this publication, which surveys the silver market to date and includes considerable material not previously available, are an analysis of the world trade in silver; the organization of the market and determination of the price; the long-term trend in the price of silver; the position of that metal in the economic life of the United States, India, and China; silver and its oriental purchasing power; the movements of treasure to and from the Orient; and—of especial interest lately—the outflow of gold from British India.

Leather in the British Empire. Production, Trade, and Raw Materials. By J. G. Schnitzer. Trade Promotion Series No. 140. Price, 10 cents.

American Cypress and its Uses. Prepared by the Lumber Division and The National Committee on Wood Utilization. Trade Promotion Series No. 141. Price, 5 cents.

Trading Under the Laws of Colombia. By Mariano H. Ramirez. Trade Promotion Series No. 142. Price, 10 cents.

Mercantile Credit Survey. Parts I, II, and III. Covering Nine of Twenty-Five Lines of Trade and Summary for Twenty-Five Lines of Trade. Domestic Commerce Series No. 74, 77, and 78. Price, 5 cents each.

World Survey of Foreign Railways. By Foreign Railways Section, Transportation Division. Subscription, $5.00 a year. 448 pages.

A survey of the steam railways (common carrier and industrial), electrified steam railways, electric railways, funicular railways, aerial cableways, tramways, and subsidiary transportation companies of the world (except the United States).

BUREAU OF THE CENSUS

Census of Distribution, Agricultural Commodity Series, *Distribution of Livestock.*

Retail Distribution, Merchandising Series, *Motor Vehicle Dealer Chains,* including Used-car and Aircraft Dealer Chains.

Retail Distribution, Merchandising Series, *Automobile Accessory Chains,* including Tire Chains and Battery Chains.

Retail Distribution, Merchandising Series, *Newsdealer Chains,* including Newsdealer-Restaurant Chains, Book-Store Chains, Stationery Chains, Art and Gift Shop Chains, and Novelty-Store Chains.

Wholesale Distribution, Trade Series, *Wholesale Trade in Paints and Varnishes.*

Prisoners in States and Federal Prisons and Reformatories, 1929 and 1930.

Marriage and Divorce, 1931.

Census of Mines and Quarries: 1929. *Alabama, Florida, Georgia; Michigan, Wisconsin, Minnesota; Pennsylvania, New York, New Jersey.*

Agriculture. *Farms and Farm Property.*

Agriculture. *Summary for All Crops.*

Construction Industry, State Series, *Arizona. Florida. Georgia. Kentucky. New Mexico. Wisconsin.*

Manufactures: 1929, State Series. *Alabama. California. Colorado. Indiana. Kentucky. Maine. Maryland. Minnesota. New Hampshire. Oklahoma. Wisconsin.*

Population. *State of Birth of the Native Population.*

Population Bulletin. Families. *California. Illinois. Indiana. Massachusetts. Minnesota. New Jersey. New York. Oregon. Pennsylvania. Texas. Virginia.*

Census of Mines and Quarries: 1929. *General Report.*

Occupation Statistics. *Marital Condition of Occupied Women.*

Occupation Statistics. *Children in Gainful Occupations.*

Occupation Statistics. *Color and Nativity of Gainful Workers.*

Occupation Statistics. *Sex and Occupation of Gainful Workers.*

BUREAU OF MINES

Mineral Resources of the United States. 1931. Summary. Price, 10 cents.

These reports made possible through the coöperation of mineral producers, accurately indicate output, values, distribution, stocks, and other factors of economic interest regarding mineral products.

Cobalt, Molybdenum, Tantalum and Titanium in 1931. I: 6. By P. M. Tyler and A. V. Petar. Price, 5 cents.

Platinum and Allied Metals in 1931. I: 7. By H. W. Davis. Price, 5 cents.

Chromite in 1931. I: 8. By L. A. Smith. Price, 5 cents.

Iron Ore, Pig Iron and Steel in 1931. I: 9. By H. W. Davis. Price, 5 cents.

Manganese and Manganiferous Ores in 1931. I: 10. By R. H. Ridgway. Price, 5 cents.

Silica in 1931. II: 10. By E. R. Phillips. Price, 5 cents.

Mercury in 1931. I: 12. By P. M. Tyler and H. M. Meyer. Price, 5 cents.

Feldspar in 1931. II: 12. By H. H. Hughes and Jefferson Middleton. Price, 5 cents.

Slate in 1931. II: 11. By Oliver Bowles and A. T. Coons. Price, 5 cents.

Antimony in 1931. I: 5. By Paul M. Tyler. Price, 5 cents.

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Vanadium, Uranium and Radium in 1931. I: 11. By F. L. Hess. Price, 5 cents.

Asbestos in 1931. II: 14. By Oliver Bowles and B. H. Stoddard. Price, 5 cents.

Gold, Silver, Copper, Lead and Zinc in New Mexico and Texas in 1931. I: 17. By C. W. Henderson. Price, 5 cents.

Sand and Gravel in 1931. II: 17. By E. R. Phillips. Price, 5 cents.

Secondary Metals in 1931. I: 18. By J. P. Dunlop.

Tin in 1931. I: 19. By C. W. Merrill. Price, 5 cents.

Mineral Production of the World 1924–1929. A Statistical Summary. I: 28. By L. M. Jones. Price, 10 cents.

Gold, Silver, Copper, Lead and Zinc in Arizona in 1930. I: 31. By C. N. Gerry and T. H. Miller. Price, 5 cents.

MILDRED R. BASHORE

Proceedings of Land Use Symposium. Syracuse University, New York State College of Forestry, Syracuse, New York (1933). 57 pages. Price, 50 cents.

During the summer session of the American Association for the Advancement of Science held at Syracuse University in 1932, an important symposium was conducted on various aspects of land utilization, proceedings of which have just been published. This symposium was one of several important conferences which have been held during the past year or more, beginning with the creation of two National Land Use Committees at a conference in Chicago in the fall of 1931.

Papers were presented at the Syracuse meetings by Doctor L. C. Gray, Secretary of the National Land Use Planning Committee, Doctor G. F. Warren of Cornell University, Mr. L. R. Schoenmann, in charge of the Michigan Land Economic Survey, and numerous other representatives of business, economics, forestry, agriculture, and geography.

The published papers present an authoritative survey of the way in which land use should be adjusted to environmental possibilities and economic demand. The first paper, by Doctor Gray, sketches the activity of the existing agencies in this field and is followed by discussions of the relation of Land Utilization to Taxes, Land Use and Forestry, the Tax Problem, Land Use and Agriculture, Land Use and Erosion, Land Use and Transportation, and Planned Land Use. This last paper by Mr. Schoenmann is of particular interest to geographers for it describes the significant activities of the Michican Department of Conservation in their inventory of the physical character of some 7,500,000 acres in the northern counties of that state. This survey, which was originally undertaken merely for the purpose of recording the condition of the land, is now broadening out to include land planning. Schoenmann's paper is made particularly valuable by the colored map showing the land use plan for Alger County, Michigan.

GEORGE B. CRESSEY

Field and Laboratory. Contributions from the Science Departments of the Southern Methodist University, Dallas, Texas.

A modest little publication, bearing an occasional article on geography, has been initiated by Southern Methodist University, and the first issue, Volume 1, No. 1, November, 1932, has just recently appeared. The editorial committee in charge of this interesting little publication is made up of Edwin J. Foscue, Chairman; Mayen Longnecker, Frank C. McDonald, and May L. Whitsitt. The first number is very nicely printed in clean, legible type, on clear paper, and well bound. The publication is intended to foster the spirit of research and to give wider publicity to scientific studies originating in, and dealing with, the Southwest.

W. ELMER EKBLAW

Rupert B. Vance. *Human Geography of the South.* 596 pp., maps, and tables. The University of North Carolina Press, Chapel Hill, 1932. Price, $4.00.

The South, including the states of Virginia, Kentucky, North and South Carolina, Tennessee, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, Oklahoma, and Texas, is presented in a regional study for the first time by Mr. Vance, Research Associate in the Institute for Research in Social Science in the University of North Carolina. Primarily a sociologist, the author presents, from a regional and human geographic viewpoint, the South "as a test of human adequacy to master the resources of its region and to develop thereon a distinctive and competent culture."

Although considered as a unit the South in-

cludes different regions in each of the fields of physiography, economics, agriculture, soils, industry, and culture. Each is considered. The historical background is presented sufficiently so that the advance to the status today is easily traced without being burdened by a mass of detailed chronological data. Man's adaptation to his environment is pictured at each important period and the geographic factors causing the changes are inserted. The lines of progress of the pioneering, lumbering, agricultural, commercial, and manufacturing industries throughout the South are portrayed in an interesting manner though the complete absence of photographs detracts from the full value of the discussion.

The three chapters devoted to climate and its relation to health, energy, diet, and human adequacy are illuminating. Dietary maladjustments of early pioneering economy in a mild climate have in most cases been the cause of paleness and lack of energy rather than the climate itself. It is predicted that with artificial regulation of the greater portion of the climatic conditions unsatisfactory for industrial efficiency a new South will rise.

Past attempts of reconstruction of the southern economy have failed in the majority of cases but the author outlines a reconstruction plan which coupled with accurate scientific data and sound cultural principles, seems to lay the foundation for the South which is to be. Even though the author agrees with the school of thought which claims that man masters his environment rather than that the environment influences man's activities, his treatment leads more to the conclusion that previously man has failed to conquer the environment and only now is responding to the ever-present environmental influence with beneficial results.

Though the maps and charts may be adequate, an increase in their number would be of assistance to the student and reader. The absolute lack of photographs prohibits a distinct picture of the southern economy and culture.

The book is of value to all geographers in that it presents in prose a true unexaggerated picture of the South and includes a prodigious bibliography of 67 pages invaluable as a source of reference material to a study of the South.

SIDNEY E. EKBLAW

NEWBIGIN, MARION I. *Southern Europe.* A Regional and Economic Geography of the Mediterranean Lands (Italy, Spain, Portugal, Greece, Albania, and Switzerland). 428 pp., 103 maps and diagrams, index, statistical summaries, and references. E. P. Dutton and Company, Inc., New York, 1933. $4.50.

A masterful contribution to the field of European Geography. The European book shelf is incomplete unless this new study by Doctor Newbigin is included. The student, traveler, and business man will find in this book a wealth of detailed information.

Doctor Newbigin is a thorough student and a natural investigator. As editor of the "Scottish Geographical Magazine" she has gained world-wide recognition. Her earlier publications are used in many lands and this most recent study is her best.

The book is intended primarily for advanced students of geography. Much space has been devoted to topics insufficiently discussed or omitted in existing texts, notably in regard to Greece and Albania, here treated with a fullness not found in any other work in English. There is no publication which gives a clearer and more complete study of the geography of Switzerland, Italy, and the Iberian Peninsula.

The book is in five parts. The three chapters of Part I are a General Study of Southern Europe, as: I. The Mediterranean Sea; II. Structure and Relief of Southern Europe; III. Climate, Vegetation, and Land Utilization. Within these pages are found 11 maps and several diagrams which add to the text.

Switzerland and the Swiss Alps are discussed in Part II. The first chapter is on the Composition, Boundaries, and Relief of Switzerland; and the second chapter on Human Geography of Switzerland. At the end of Part II, as well as the parts which follow, are two or three pages of statistical summary and references. Fifteen sketch maps and diagrams add to these 49 pages.

Part III deals with Italy. The 97 pages are divided under the following four chapters: VI. Italy: Structure, Relief, and Natural Divisions; VII. The Alpine Borderlands, The Northern Plains, and The Marginal Areas; VIII. Central Italy; IX. Southern Peninsular Italy and The Islands. There are 26 maps and several diagrams in these chapters.

In the daily news of the past two or three years Italy has had a prominent place. This geographical discussion of that country is particularly helpful in gaining a clearer picture of conditions there.

The Iberian Peninsula is carefully presented in Part IV. Chapter X with its 19 pages covers the Structure and Relief of the Iberian Peninsula; XI with 22 pages considers Climate, Vegetation, and the Human Response to the Natural Conditions; XII. The Peripheral Natural Regions covers 33 pages; and XIII has 19 pages on The Ebro Basin and Castilian Tableland. There are 15 maps and several diagrams.

The final study is devoted to Greece and Albania. Part V has 79 pages divided into four chapters, as: XIV. General Survey of Greece; XV. Central Greece, The Peloponnesus, and the Islands; XVI. Northern Peninsular and Mainland Greece; XVII. The Kingdom of Albania. There are 15 helpful maps and many diagrams in this last part.

This book will make a fine text for the study of Southern Europe. The study will hold a ranking position in European Geography for all time.

LAWRENCE F. FOUNTAIN

HAWKS, ELLISON. *The Romance of Transport.* 333 pp.; 157 illustrations. Thomas Y. Crowell Company, New York. $3.00.

The evolution of transportation from the dawn of history to the present day is very ably presented in the "Romance of Transport" by Ellison Hawks. It is a stimulating narrative. The reader's attention is held from beginning to end, each chapter being a unit of interesting facts.

In the preface the author gives this quotation by Kipling: "Transportation is Civilization." This fact impresses the reader throughout the entire book.

There are 110 very fine halftones and 47 line cuts of the many types of transport. These illustrations are of inestimable value to such a study and the author is to be commended on the fine collection.

The book begins with a study of the earliest recorded methods of transport. The facts and events from these early times to the present are given in chronological order. The Chapter headings impress one with the desirability of such a book. They are as follows:

I. Beasts of Burden
II. Transport without Wheels
III. The First Wheeled Vehicles
IV. Stage-wagons, Hackney-Carriages, Post Chaises, and Cabs
V. The Coach
VI. The Horse-Drawn Omnibus
VII. From Roman Roads to British Turnpikes
VIII. The Development of Modern Roads
IX. How Railways Began
X. The Coming of the Railway
XI. Mechanical Road Transport: From Steam Carriage to Motor-Cycle
XII. Mechanical Road Transport: From Motor-Car to Tractor
XIII. Inland Water Transport
XIV. Ocean Transport: Wooden Ships
XV. Ocean Transport: Iron and Steel Ships
XVI. The Story of the Airship
XVII. The Story of the Aeroplane
XVIII. Air Transport Today

Mr. Hawks has written many books on technical and scientific subjects such as "The Book of Remarkable Machinery," "The Book of Electrical Wonders," "Pioneers of Wireless," and "The Romance of the Merchant Ship." He is editor of the Meccano Magazine, a monthly with a large circulation among boys of all ages in all parts of the world.

This book on "The Romance of Transport" is an excellent contribution and a worthwhile addition to any library.

LAWRENCE F. FOUNTAIN

ANNOUNCEMENT

THE series on the *Agricultural Regions of the World* is continued in this issue with an instalment of *Agricultural Regions of Asia* by Dr. Samuel Van Valkenburg and an instalment of *Agricultural Regions of North America* by Dr. O. E. Baker. Another instalment of *Agricultural Regions of North America* by Doctor Baker will appear in the July issue. This will be followed in a later issue by *Agricultural Regions of Africa* by Homer L. Shantz, President of the University of Arizona, and will complete the finest geographic discussion of the world's agriculture thus far published.

To obtain the complete series of these extremely valuable articles, which present for the first time on such a comprehensive and accurate basis the significant divisions of the world's most important industry, it will be necessary to subscribe at once for ECONOMIC GEOGRAPHY, and to order the several back numbers.

In addition to this series of articles on agriculture, other series are being initiated; every issue will also contain four or five articles dealing with urban and regional geography, with problems of land utilization, with programs of development of resources, with commerce, with transportation, with health, and with the hundred and one other subjects that are of present geographic interest, all by the most competent and best-informed authorities in their respective fields. ECONOMIC GEOGRAPHY is indispensable to the intelligent citizen.

The subscription price to all new subscribers in the United States and possessions is $5.00 the year or $9.50 for two years. To all foreign countries, $5.50 the year or $10.00 for two years. Complete files from the beginning to include the numbers for 1932 may be obtained at the special price of $37.50 for the United States and $40.00 for all foreign countries.

ECONOMIC GEOGRAPHY

A QUARTERLY journal of ECONOMIC GEOGRAPHY published by Clark University for the benefit of geographers, economists, teachers, professional and business men, and all who are interested in the intelligent utilization of the world's resources.

Subscription rates are $5.00 the year in the United States and its Territories; $5.50 the year beyond the borders of the United States, except to charter subscribers.

Only a limited number of the first issues of ECONOMIC GEOGRAPHY are available.

The January issue of Volume 9 contains the following articles:

Agricultural Regions of Asia, Samuel Van Valkenburg, Clark University.
The Coast Plains of South India, Ethel Simkins, University College of the South West of England, Exeter, England.
A Southern West Virginia Mining Community, Raymond E. Murphy, Pennsylvania State College.
The Oahu Sugar Cane Plantation, Waipahu, John Wesley Coulter, University of Hawaii.
Kilgore, Texas: An Oil Boom Town, William T. Chambers, Stephen F. Austin State Teachers College.
Where Florida Truck Crops Are Grown, John L. Wann, University of Florida.

The October issue of Volume 8 contains the following articles:

Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.
Nomadic Pastoral Regions, Wellington D. Jones, University of Chicago, and Derwent S. Whittlesey, Harvard University.
Pattern of Copper Mining Terrene Occupancy in the South Range, Keweenaw Peninsula, Robert S. Platt, University of Chicago.
Economic Aspects of the Danubian Plan, Joseph S. Roucek, Centenary Junior College, Hackettstown, N. J.
The North Kansas City Urban District, John Q. Adams, University of Missouri.

July includes:

The Ports of Finland, Karl Kekoni, High School, Ekenäs, Finland.
Agriculture of the Southern High Plains, J. Sullivan Gibson, Western Kentucky State Teachers College.
The Banana in Caribbean Trade, Jesse T. Palmer, University of Illinois.
Iron and Steel Industry of Wheeling, West Virginia, Langdon White, Western Reserve University.
Competing Cottons and United States Production, William G. Reed, George H. McFadden & Bro., Philadelphia, Pennsylvania.
Economic Adjustments on the Olympic Peninsula, Albert L. Seeman, University of Washington.
Wild Plant Industry of the Southern Appalachians, Ina C. Yoakley, State Teachers College, Johnson City, Tennessee.

April includes:

Agricultural Regions of Asia, Samuel Van Valkenburg, College of the City of Detroit.
Manchuria: The Land and Its Economy, John R. Stewart, National Credit Office, New York.
Export Wheat Producing Regions, Helen M. Strong, Bureau of Foreign and Domestic Commerce.
Importance of Pipe Line Transportation, John K. Rose, Clark University.
Classification of North American Climates: A Review, Stephen B. Jones, Harvard University.

January includes:

Land Utilization in the Lower Rio Grande Valley of Texas, Edwin J. Foscue, Southern Methodist University.
Agricultural Vermont, S. Axel Anderson, Columbia University, and Florence Woodard, University of Vermont.
The Population of the Netherlands, J. F. Bogardus, University of Pennsylvania.
Coffee Industry of Central America, Louise Hearst, Iowa State Teachers College.
Edwards Plateau, A Combination Ranching Region, William T. Chambers, Stephen F. Austin State Teachers College.
Buffalo as a Flour Milling Center, Laura O'Day, Buffalo Museum of Science.
Dry Farming in the San Joaquin, California, Samuel N. Dicken, University of Minnesota.

The October issue of Volume 7 contains the following articles:

Agricultural Regions of North America, Oliver E. Baker, U. S. Dept. of Agriculture.
Sheep Rearing in New Zealand, R. Ogilvie Buchanan, University of London, University College.
The Significance of Drain Tile in Indiana, W. LeRoy Perkins, University of Chicago.
Economic Geography of Roumania, Joseph S. Roucek, Centenary Junior College, Hackettstown, N. J.
Fiji Sugar Industry, C. J. Robertson, International Institute of Agriculture, Rome, Italy.
Trans-Montane Routes of Colorado, Ralph H. Brown, University of Minnesota.

Single copies of back numbers of Volumes 1 to 5 inclusive will be sent to any American address for $1.75 each; to any foreign address for $2.00. Back numbers of Volumes 6 to 8 inclusive, will be sent to any American address for $1.50 each; to any foreign address for $1.75. Whole volumes may be obtained at the yearly rate.

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ECONOMIC GEOGRAPHY

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ECONOMIC GEOGRAPHY

Published Quarterly by

Clark University, at 10 Ferry Street, Concord, N. H.

Editorial Office, Clark University, Worcester, Massachusetts

PRICE, $1.50 THE CURRENT NUMBER

FIVE DOLLARS A YEAR
(except to charter subscribers)

Entered as second class matter at the Post Office at Concord, N. H., under the Act of March 3, 1879

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SOUTH AFRICA

SOUTH AFRICA suffers economically and culturally from her position at the tip of one of the large peripheral peninsulas of the world's land mass. She is still relatively remote from the centers of population and their stimulating activities, despite the diminished barrier effectiveness of distance. Her ties with England, the center of the land hemisphere are yet politically strong, but socially weak. Her interests seem to shift Pacificward rather than to continue toward the Atlantic. Her development proceeds fastest and most successfully along her eastern margin. Thus does her location tend to direct her destinies.

South Africa lies on the transitional border between the tropics and the temperate lands, between the trade winds and the prevailing westerlies. With a summer rainfall régime of only 20 inches or less, her grassland economy is likely to dominate her agricultural development. With great variety of temperatures between the low valleys, the coast lands, and the high plateaus, her crops, wherever they can be successfully grown, are sure to be diversified and complementary. An abundance and variety of food seems insured to her people.

Her coal fields, her gold mines, her diamond pipes, her potential mineral wealth in iron and other metals are likely to continue an important factor in her progress, becoming increasingly important with denser settlement and stabilized industry. Her wealth of fish in the neighboring waters indicates a great industry when conditions warrant. Her adequacy of cheap labor, not skilled but capable of intelligent application to agriculture, particularly stockraising, and industry, gives promise of successful competition with other lands.

Despite her distance from the great centers of population and intense human activity, South Africa bids fair to become a power to be reckoned with, if not in world affairs, then certainly in African affairs and the trade of the Indian Ocean and its environs.